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IMPROVED RAPID TRANSIT FACILITIES ON THE BROOKLYN BRIDGE.

The report of the Commission of Expert Engineers on the feasibility of running electric surface cars and elevated railway trains over the Brooklyn Bridge, in addition to the operation of the existing Bridge railway, sets at naught all fears as to the ability of the structure to bear, with safety, the additional strains thereby introduced. When Mr. John A. Roebling designed the great structure he gave it a very large factor of safety, foreseeing, no doubt, that its ultimate stability would, before the lapse of many years, be put to a test. The proposed improvements, the Commission says, can be carried out with safety, and with their inauguration the ultimate capacity of the Bridge will be about reached. While these improvements will afford much temporary relief in the transportation facilities between the two cities, we are of the opinion that the maximum capacity thus afforded will be reached sooner than most people believe, for the simple reason that the increased facilities will naturally invite greater use of the structure To be able to go to any part of Brooklyn from the New York end of the Bridge, and *vice versa*, without a change of cars has been for years a desideratum most devoutly wished for by the people of both cities, and now that it seems about to become an accomplished fact, Brooklyn's star seems to be ascendant.

The plans for accomplishing these desirable results have been very ingeniously worked out with the primary object of quickly handling the traffic and, judged from an engineering standpoint, they seem to offer an excellent solution of the difficult problems presented. We print on another page in this issue a brief description and plan diagrams of the proposed improvements, which will be found of considerable interest.

THE ALTERNATING-CURRENT ARC.

The difficulties involved in the study of the electric arc, the discrepancies which exist between the results obtained by various investigators due to the different conditions under which their experiments have been carried on, and the want of a precise method of photometric measurement, have left this most attractive branch of investigation in practically an indeterminate state, and with little or no possibility of co-ordinating the data at hand. Few experimenters have given as much attention to the study of the electric arc as has Prof. Blondel, and few therefore are as capable of removing some of the foggy concepts from the minds of those who have studied previous discussions on this subject. Many will doubtless read with particular interest therefore, Prof. Blondel's article on the "Luminous Efficiency of the Alternating Current Arc," the first installment of which appears in other columns of this issue. He has pointed out that the uncertainty which exists in regard to the relative efficiencies of the alternating and direct-current arcs has been due to a want of a proper method of photometrically measuring the mean spherical intensity and a neglect to properly consider the length and character of the arc observed. Prof. Blondel has employed a special form of photometer, which he has devised and for which he claims most accurate results. The color of the light measured is a source of error which he has attempted to correct by using colored screens in conjunction with a standard Hefner lamp.

The dependence of the luminous efficiency of the arc upon the size of carbons used has been noted by Schreihage, who has pointed out that for homogeneous carbons the candle-power varies inversely

as the diameter of the carbons, a statement which he modifies by excepting wide ranges in the size of carbons and the measurement of the mean horizontal candle-power. Prof. Blondel points out, however, that this assumption is not even approximated, principally owing to the fact that Schreihage neglected to consider the distance between the carbon points. This distance he finds has a most important bearing on the efficiency, which corroborates the statements of Görges to the same effect, based upon the belief that a greater temperature of the carbon exists when the carbon points are near together. Prof. Blondel finds that in the alternating-current arc the best effect is obtained by having a homogeneous lower carbon and a cored upper carbon of the ordinary size. He takes exception to the statement of Rössler to the effect that the greatest efficiency is obtained when using E. M. Fs. of rectangular wave form, a form, by the way, which is almost completely rounded off in an inductive circuit. As pointed out by Prof. Blondel, if it were possible to obtain in commercial practice a rectangular current-wave, then the advantage of having the duration of the extinction of the arc reduced to a minimum would permit of obtaining a higher luminous intensity. Prof. Blondel could not detect any increase of efficiency with an increase of frequency, but, on the contrary, a notable diminution in the total flux was apparent. The general conclusions which can apparently be drawn are that the direct-current arc has not the superiority over the alternating-current arc that is generally imagined ; that a rectangular form of current wave would permit of the highest efficiency being attained, but the want of a practical means of providing such makes this consideration of theoretical interest only ; that with alternating-current arcs carbons of small diameter should be employed, long arcs avoided and low frequencies consistent with an absence of flickering used.

FLEXIBILITY IN THE TRANSMISSION AND DISTRIBUTION OF ELECTRICAL ENERGY.

The rapid progress in electrical power transmission which has taken place within the past five or six years has necessitated on the part of the pioneers in this branch of electrical engineering—where it has been desired to attain the efficiency, reliability and economy which modern practice permits of—the discarding of old methods, the throwing out of old yet useful apparatus and practically commencing anew. Such has been the experience in not a few instances, and neither are these exclusively confined to power transmission to any considerable distance, but even those supplying comparatively limited areas. Those who have passed through this experience, those who contemplate such changes, and those more or less interested will find most profitable reading in the article by Prof. Robb on the Hartford Transmission Plant, the first installment of which appears in this issue. Owing to the necessity of using old apparatus and buildings in order to effect the changes desired at the minimum cost, the plant, as reconstructed, does not present the appearance that would result from an entirely new installation, but nevertheless the features of transmission and distribution will for this reason lose none of their interest and value. As Prof. Robb has given no figures setting forth the relative efficiencies and the cost of supplying electrical energy by the old and new methods as employed in Hartford, many will doubtless question the advisability of introducing the apparent complications which this plant represents, yet the conservative and successful management in the past of the Hartford plant warrants the belief that the changes which have been inaugurated will lead to equally successful results. These changes have, however, not necessitated the complete abolition of the old apparatus, but the same has been utilized in combination with the most modern types, resulting in one of the most flexible plants which has thus far been installed. As stated by Prof. Robb, the problems to be overcome consisted in increasing the water-power, making the load more constant, effecting a more efficient transmission, raising the efficiency of the existing steam plant and placing some of the wires under ground in the central part of the city. To aid in bringing about these results advantage has been taken of the greater ease of balancing a two-phase system and the possibility of distributing lights on independent circuits when using this system for distribution, while the advantages of the three-phase system, both as to line inductance and amount of copper required, have been attained by using this system in the transmission. The power required for the street railway and arc-light circuits and the low-potential three-wire distribution necessitated the continuance of the direct-current service for these purposes. The advantages to be derived by the use of a storage-battery plant have been made use of with the result that not only may the load variations in the distributing system be equalized, but either water or electrical energy may be stored at pleasure. The power transmitted from the main power house at Farmington River is partly distributed directly for lighting, partly to operate the two-phase rotary transformers which in turn supply the battery, and partly to supply a large synchronous motor direct-coupled to a shaft which in turn drives the railway generators and arc light machines. This synchronous motor may act either as a generator or motor and automatically changes its functions as the load demand requires. When acting as a generator it is driven by the auxiliary steam engines and runs in parallel with the main power generators nearly 11 miles distant, or should the transmission line fail, directly supplies the city service. For the ordinary demands of the service the synchronous motor permits of shutting down the steam plant, so that the latter may always be operated under the most favorable conditions for maximum economy. If required, the storage battery may be used to supply the rotary transformers which in turn would furnish power to the synchronous motor. The system therefore is one of the greatest flexibility and the results of its actual operation will be awaited with considerable interest.

Death of Galileo Ferraris.

Prof. Galileo Ferraris died in Rome on Feb. 7. At the time of his death he was principal and professor of Technical Physics and Electrotechnics, at the Royal Museo Industriale Italiano, in Turin, and a member of the Italian Senate.

Born in Livorno in 1847, he was graduated with the degree of Bachelor of Mathematics and Civil Engineer, from the University and Engineering School of Turin, in 1869. He was immediately appointed assistant professor in the Museo Industriale, and had devoted his whole career to physical science and electricity.

Prof. Ferraris is best known through his researches and writings upon alternating-current phenomena. Easily the foremost electrician in Italy, he held during his short life many positions of honor in scientific bodies, and but a month before his death was elected the first president of the Associazione Elettrotechnica Italiana of Milan. He was one of the vice-presidents of the International Electrical Congress in Chicago in 1893. For a more extended biographical sketch of Prof. Ferraris, the reader is referred to The Electrical World of Aug. 26, 1893, page 148.

The Light of the Future.

According to Prof. Ebert, the well-known German physicist, a single horse-power would be sufficient to run 46,000,000 Puluj lamps of sixteen candle-power. This is a phosphorescent lamp constructed 15 years ago, and consists merely of a piece of mica painted with sulphide of calcium, and subjected to the action of cathode rays in a vacuum. According to Prof. Lodge, if it becomes possible to convert mechanical energy into light alone, a single man turning a crank could develop sufficient energy to light a whole city.

Report of the Edison Electric Illuminating Company of New York.

The annual report of the Board of Directors was issued to the stockholders of this company at their annual meeting Feb. 9, 1897.

The president reviews the earnings and the general results obtained by the company during the past year, but a more detailed record is given by the vice-president's report. This latter report shows that there has been an unusual increase in current supply from the Edison low-tension stations, reaching 125,000 sixteen-cp equivalent, which is nearly 28 per cent. over previous increases. This increase is largely in power business, and, it is claimed, exceeds the total installation during the past year of any other electrical supply company in this city.

The high-tension companies, operated under the supervision of this company and constituting practically the high-tension division of this company, had on their station service Dec. 31, 1896, 29,964 incandescent and 2334 arc lights, and 23 horse-power in motors, or an equivalent of $53,649, which, added to the Edison station service, gives a total of 613,991, or, with isolated plant service, 708,458 sixteen-cp equivalent.

The annex generating plant in the Produce Exchange Building was entirely removed and in its place provision was made for a storage battery annex in the new Bowling Green Building, using the existing distributing centre adjoining the Produce Exchange. It includes a storage battery of 8000 ampere-hours capacity at a 10-hour discharge rate, or 4000 amperes at 125 volts for one hour. It has been practicable to keep the large units at the Duane Street station operating at practically full load and with the minimum economy during the hours when these are in use. The several changes and additions in the Twelfth Street station, Fifty-third Street station and Twenty-sixth street station are mentioned, and at the Thirty-ninth Street station the equipment has been extended by the addition of a 300-hp De Laval steam turbine driving two 100-kw dynamos. This is the second generating set of this kind installed by the Edison Company, the other being located at the Twelfth Street station. An annex station has been installed on premises temporarily leased at Seventy-second Street and Fifth Avenue. At this station the high-tension, two-phase, alternating-current service from the Manhattan Company's plant at Eighteth Street and Avenue B operates a 240-kw two-phase motor at 2000 volts. This motor drives two 100-kw 35-volt Edison direct-current dynamos, which re-enforce the supply in the upper district pending the further development of the Fifty-third Street station.

The downtown district, including the Duane Street station and the Bowling Green annex, reached in 1896 a maximum load of 37 250 amperes, Dec. 15, the equivalent of nearly 88,000 16-cp lamps lighted at one time.

The uptown district, including the Twenty-sixth Street station, the Twelfth, Thirty-ninth, Fifty-third Streets and Manhattan annex stations, run as annexes, reached during the year a maximum load of 42,590 amperes, Dec. 23, the equivalent of over 100,000 sixteen-cp lamps.

At the several stations the maximum load of the year was reached at the Duane Street station, Dec. 4, with 35,750 amperes; at the Bowling Green storage battery, Dec. 3, with 2800 amperes; at the Twelfth Street station, Dec. 21, with 7990 amperes; at the Twenty-sixth Street station, Dec. 15, with 21,900 amperes; at the Thirty-ninth Street station, Dec. 28, with 10,400 amperes; and at the Fifty-third Street station, Dec. 3, with 6975 amperes; and at the Manhattan annex, Dec. 25, with 1550 amperes.

The highest load of the entire system taken together was on Dec. 15, a maximum of 79,360 amperes. The best daily average of the system was on Dec. 22—28,926 amperes.

The total current generated in the year was in the downtown district—68,738,565 ampere-hours—and in the uptown district, 84,581,417 ampere-hours; in both districts a total of 153,319,982 ampere-hours.

By means of the storage battery at the Twelfth Street station the generating plants of the entire system with the exception of the Twenty-sixth Street station, were shut down on several occasions over night or over Sunday for the purpose of testing the practicability of running the entire system from one generating plant during the hours of minimum load. The results show that this is quite practicable, and with the aid of the new storage battery in the Bowling Green station, it is probable that considerable economy will be developed in this way during the coming year. Seven hundred and nineteen new service connections were added to those already installed. Some of the old two-wire underground distribution has been removed, leaving only about .17 of a mile of this system still in use. The total mileage Dec. 1, 1895, including 1.41 miles of cable feeders contiguous to the stations, was 202.92 miles of mains and feeders; the system also included at the same date 1160 junction boxes at intersections with an increase of 48. The net increase of the entire system is 6.41 miles of underground mains and feeders, bringing the grand total Dec. 31, 1896, to 209.33 miles.

The development of the electric meter service has been increased. In connection with complaints regarding the incorrectness of meter readings it may be mentioned that 14 of the 23 technical deficiencies found were due to the freezing of the meter bottles during extremely cold weather.

Interior Conduits.

BY WILLIAM A. ANTHONY.

The recent discussions in relation to the use or non-use of an insulating lining in the iron pipes used for conduits for electric wires, leads me to present for the consideration of the readers of THE ELECTRICAL WORLD my own views upon the subject.

The main claim by those who favor plain iron pipe is that whatever advantage may be derived from the insulating lining of the pipe, may be as well derived from an extra thickness of covering on the wire.

At the recent meeting of the insurance inspectors in this city, a resolution was offered by the representatives of the New York Board looking to the approval of the use in plain iron pipe of a wire having a covering equivalent in all respects to the usual insulating covering approved for wires used in lined conduits, *plus* the lining of the tube. Now this is all very well if such a covering could be made, but it seems to me that the adoption of such a resolution would be equivalent to adopting a resolution to the effect that we will approve for use in place of the steel frame and hollow brick partitions of a fireproof building, wood beams and partitions having the same strength, incombustibility and resistance to heat.

The high insulation of the high-grade rubber-covered wires used for interior wiring is due entirely to the rubber covering; the layers of braid over the rubber add not one iota to the insulation resistance, but only afford mechanical protection to the rubber covering. For wires that are to be drawn into conduits, thick, heavy coverings of braid are very objectionable, since they greatly diminish the flexibility of the wire, and increase the difficulty of drawing it around angles or bends in the conduit, and so increase rather than diminish the danger of the covering being torn and the insulation impaired in the process of drawing in the conductor. Some experiments that I have undertaken, but have not yet completed, tend to show that the insulation of a heavily covered conductor, like the "Attix" wire, is much more quickly impaired by bending than is that of the ordinary standard insulated wire.

If plain iron pipes are to be used at all for conduits, there is no better insulated conductor to draw into them than the standard wires and cables now used for the insulated conduits. The idea that additional coverings of braid will lessen the chances of injury while the wire is being drawn in, or will serve to lessen the probabilities of deterioration afterward, is an error.

The danger of injury during the drawing of the wire into plain iron pipes is mainly due to the roughness of the interior, to the fins and splinters that always exist on the inside of pipes, and to the burrs and sharp corners left in cutting. The interior roughness is entirely covered by the insulating lining in the lined pipes, and the burrs turned in by cutting do not reach through the lining. The lining itself is a far better insulator than the extra braids on the outside of the insulated cable can possibly be, considering that the cable is being continually bent and twisted in the handling, until it is finally in place in the conduit. As a mechanical protection to the wire while it is being drawn into the conduit, the lining in the pipe is infinitely better than any extra covering on the outside of the wire—that must be bent and twisted and subjected to all the strains incident to the handling of the wire—can possibly be.

But there is still another danger. In spite of all precautions moisture will get into the conduits. Against this moisture the extra covering on the wire is absolutely no protection. All that the wire is with it, it would be without it. But the inside of the unlined iron pipe will rust, and this rusting is a menace to the insulation on the wire. The lining in the iron pipe, adhering as it does closely to the inner surface, will protect the pipe from rusting and so tend to preserve both pipe and wire.

If plain iron pipe is to be used at all for conduits it must in some way be rendered absolutely smooth and free from fins and splinters inside. All burrs caused by cutting must be conscientiously removed, and all sharp corners carefully rounded. Then, for the conductor to be drawn into it, I repeat there is nothing better, nothing else so good, as the standard high grade wires and cables now used. But no one would claim that such an installation would possess the same advantages as an installation consisting of the same wire drawn into a pipe having an insulating lining, and it seems to me the height of absurdity to suppose that the advantages of the insulating lining can be obtained by putting an extra covering on a wire that already possesses little enough flexibility.

American Exportation of Electrical Machinery.

BY GEORG KIRKEGAARD.

While the manufacturers of electrical machinery in this country have exported goods to a great extent to South America, Japan and to some extent to Southern Europe, they have, up to date, almost entirely ignored the vast market of the Northern part of Europe: Denmark, Sweden, Norway, Finland and Russia. These countries bordering on the Baltic, excepting Norway, have a population of many millions.

Electricity is there used to a great extent, and for numerous purposes. The machinery is, in most instances, imported either from Germany or England. Why does this country not export? Is it because these countries do better or cheaper work than we? No; the reason is that the manufacturers here have never paid any attention to this large field for supply, the general opinion prevailing that we cannot compete with the cheap labor in Europe.

The fact is, we are far ahead in skilled labor and in working machinery and tools; we are not only able to sell just as cheap, but as to workmanship our machines are superior to those of Germany or England.

Take for instance Copenhagen, the capital of Denmark; there they have a large central station, delivering current both for light and power on the same principle as here. The plant was built by Siemens & Halske, the whole outfit imported from Germany. The streets are lighted with Shuckert's arc lamps, two in series on 110 volts consuming 8 amperes, but these lamps do not give satisfaction; they burn unsteadily and do not come up to the standard of American lamps.

The writer, who a year and a-half ago presented the Technical Institute, in Copenhagen, with two American lamps, received some time ago a letter from the director of the Institute, stating that they had about 100 arc lamps of German make in use, but none gave such satisfaction as the two American lamps. The director now wishes to replace the German with American lamps. As to the prices for these lamps imported from Germany, the Institute paid 80 Kroner ($21.50) each for plain lamps. Compare this with prices on our market to-day, and I think we are more than able to compete with any of those countries. (The duty on arc lamps in Denmark is 3½ cents per lb.).

The facilities for opening trade with these countries are second to none. The large Free Port of Copenhagen, which the Danish Government has built with a cost of over $10,000,000, has direct connection with this country through three steamship lines. The Free Port covers over 300 acres of land, and many warehouses, factories and elevators are built all over, all fireproof and lighted by electricity. Goods are stored here for a minimum charge, and duty is only charged when goods are shipped outside the gates into the country.

Goods reshipped from the Free Port to any other country are exempt from duty to the Danish Government, hence the name the Free Port.

Americans will find no difficulty in dealing with people in Northern Europe, as most of them speak and correspond in the English language; furthermore, business there is carried on on a cash basis, thereby lessening the complication and risk with notes, etc.

Mr. Charles E. Currie visited Copenhagen last Summer as the representative of the Board of Trade of Louisville, Ky. The result of his visit was that seven American firms through his efforts to-day are trading with Northern Europe, through the Free Port of Copenhagen. See his report in the *Tradesman* of Jan. 1, 1897.

If Americans are going to visit Scandinavia this coming Summer, a great attraction for them will be the industrial exhibition at Stockholm, Sweden, where the Scandinavian countries as well as Finland and Russia will show their skill in industry and art. A prominent part of this exhibition will be the electrical department.

American manufacturers ought to send representatives over to investigate for themselves to what extent goods from this country could be exported. The result would surely be a larger exportation of electrical machinery and supplies than any one dreams of.

Westinghouse Lamp Patents.

Public announcement was made last week that the Westinghouse Electric & Manufacturing Company was now enforcing certain lamp patents owned by itself, which had lain dormant for several years, and requiring manufacturers of lamps made in accordance with the processes involved to pay royalty.

In order to understand the new situation more clearly it will be necessary to refer to the lamp case as it existed a few years back, and lead up to the present.

The Edison lamp patent, which was sustained by the courts and was claimed to broadly cover the incandescent lamp, expired in this country on Nov. 17, 1894, by reason of the termination of the Canadian patent on the same invention. The Sawyer-Man patent for which a similar claim was made was declared invalid by the courts (the McKeesport *vs.* Consolidated Electric Light Company case), the final decision by the Supreme Court having been made on Nov. 11, 1895. These were probably the two most important patents affecting the incandescent lamp industry and the litigation regarding incandescent lamp patents was until recently mainly confined to those two pate nts.

Now that the litigation which formerly absorbed so much money and attention is at an end, the Westinghouse Company is enforcing its other patents which are still in force. The company owns between 40 and 50 such patents, the most important of which is that issued to Mr. Edward Weston during the latter part of 1882, covering cellulose filaments, which are now extensively used in incandescent lamps.

Three of these patents are considered vital; one covers the structureless filament (cellulose and collodion, collodion being a form of cellulose); the second covers fibrous filaments, such as twisted or braided silk, treated or flashed, and the third a method of treating filaments. The other patents cover various features of the incandescent lamp and processes of manufacture.

The ultimate period of life of the three patents, which are regarded in the present state of the art as unavoidable in the manufacture of the best lamps, is said to be about six years, and until their expiration the manufacture of incandescent lamps of the cellulose or the fibrous filament types cannot be regarded as being a right inherent in the public.

In enforcing these patents the Westinghouse Company asserts that it is pursuing the policy of granting to other lamp manufacturers licenses under these patents at moderate rates, and most of the principal lamp companies, it states, have taken out such licenses and are now paying a small royalty to the Westinghouse Company.

We are informed on the best of authority that the royalty exacted on standard 16-cp lamps is a small fraction of a cent on each lamp, and that 95 per cent. of the lamp output pays the minimum royalty. The extra and fancy grades of lamps pay a higher royalty, but according to the Westinghouse figures, these amount to only 5 per cent. of the total output. It is stated that the income to the Westinghouse Company from these royalties, the charging of which began on Jan. 1, last, will be much less than $100,000 a year.

Inasmuch as the recent patent combination between the General Electric Company and the Westinghouse Company did not include the lamp patents owned by the latter company, the Westinghouse Company is in a position to act entirely independently in the matter.

Over 70 per cent. of the lamp manufacturers of this country, including the General Electric Company and all other prominent makers, have taken out licenses from the Westinghouse Company. The royalty required by the Westinghouse Company, it is stated, is hardly sufficient to warrant any increase in the price of lamps to the consumer, but on inquiry we find that in some cases prices have been or will be advanced.

The Westinghouse Company, we understand, is not a member of the lamp pool, and is in no way concerned in its affairs.

The Westinghouse Company proposes, so we are informed, to take legal proceedings against those concerns who have not taken out licenses and are manufacturing lamps in infringement of its patents.

The Long-Distance Transmission of Power at Hartford.

BY WILLIAM LISPENARD ROBB.

THE Hartford Electric Light Company was one of the first in this country to make use of water-power in generating electricity, and to transmit the electricity so generated to any considerable distance. In 1889 the company contracted for the total amount of power that could be furnished by the Farmington River Power Company at its power house on the Farmington River, 10.8 miles from the central station in Hartford. This power was first utilized in 1890 to operate the generators used in street lighting. The results proved so satisfactory that in 1891 a single-phase alternator was started and operated at approximately 2500 volts. This was replaced the following year by two 120-kw single-phase alternators, which were used for operating the alternating-current incandescent lighting system. The current was generated at 1200 volts pressure and by use of step-up transformers raised to 7000 volts, and at the Hartford central station reduced by step-down transformers to 1200 volts.

Early in 1893 a three-phase generator of 300-kw capacity was installed at the power house and supplied current to operate a three-phase motor connected with the shaft in the Hartford station, and so helped the steam plant in operating the company's direct-current generators.

The experience of the past five years so conclusively demonstrated the great economy in operation by the use of water power, and the reliability and efficiency of the long-distance transmission of the power so obtained at high voltages, that it was decided during the past year to materially increase the size of the power plant and at the same time make such changes in the electrical machinery as would increase the efficiency of the transmission and give a more constant load to the water-power.

The Farmington River is one of the most constant sources of water-power in New England. A large portion of the watershed is woodland, and large reservoirs have been built up the river by an association of manufacturers whose mills are operated by the numerous small powers along the river. Government reports state that the minimum flowage of the river is about 60 per cent. of the average.

The electric light company operates two stations in the city. One, the State Street station, is in the centre of the business district, and exceptionally well located for economical distribution on the three-wire 220-volt system, which was adopted as the most economical one to use in a district where the wires are placed underground. The second, or Pearl Street, station is situated on the edge of the underground district, a name given to the part of the city in which the company is putting its wires underground. This station was therefore easy of access for the overhead system and furthermore was equipped with a modern steam plant.

This introductory sketch is given to indicate the engineering problems, of which the recent extensive changes made in the system are considered a satisfactory solution. Briefly stated, the problems to be solved were: To increase the water-power; to make the load on the water-power more constant for the entire 24 hours; to make the transmission more efficient; to cease operating one steam plant and to operate the other during one shift only; to place the wires in the central part of the city underground; while making these extensive changes to interfere as little as possible with the existing method of distribution on the overhead high-tension system.

These problems were solved in the following manner:

In 1889, when the old dam was built, the success of the long-distance transmission of power was considered very uncertain. In consequence, a comparatively cheap method of construction was followed in building the dam. It was built of wood, with vertical face and wooden abutments. The original dam was 18 feet high. During the past Summer it was raised five feet and at the same time greatly strengthened by building on an apron and replacing the wooden abutments with stone. Fig. 3, in which the cross-sectional portion represents the old dam, shows the method of construction followed in raising and strengthening it.

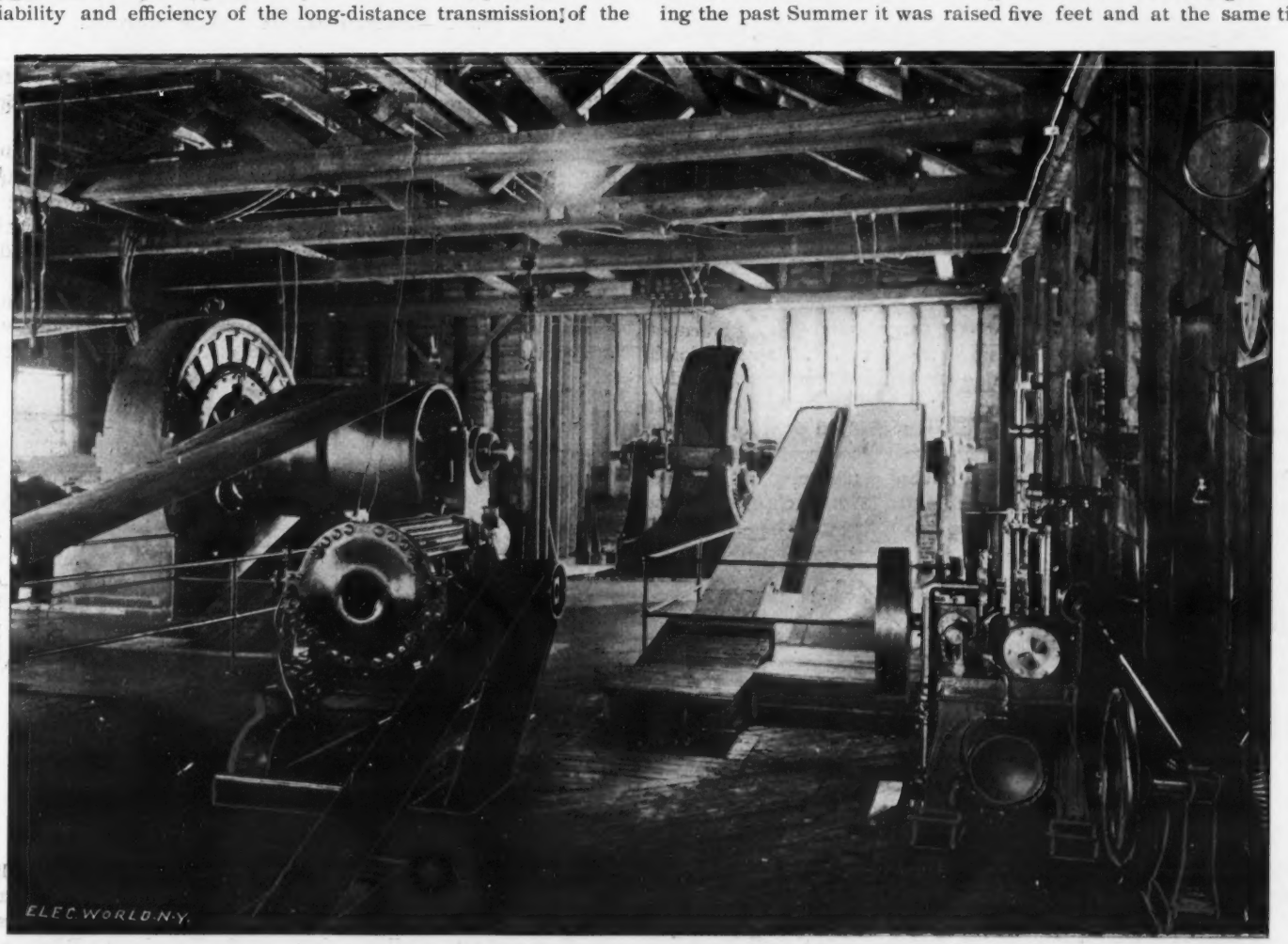


FIG. 1.—POWER STATION AT FARMINGTON RIVER.

The power is generated by four sets of horizontal turbines, two be-

ing connected by belts to each generator, the pulley of the generator having a double crown. (Fig. 1.) The turbines are of the McCormick and Rodney Hunt types and have a total capacity of about 1600 horse-power. Lombard governors are used as regulators. This type of governor maintains stored up at all times a considerable amount of energy in the form of compressed air. As a consequence they are capable of shutting down the gates completely in about two seconds, in case of any emergency such for example as may arise at any

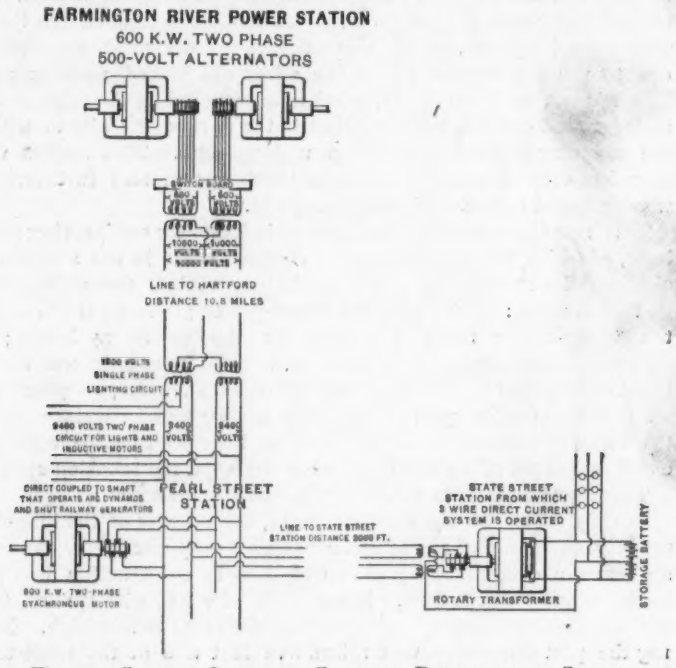


FIG. 2.—SKETCH SHOWING GENERAL PLAN OF THE SYSTEM.

time from the line opening and the consequent throwing off of entire load.

The power is utilized by two 600-kw, two-phase alternators, manufactured by the Westinghouse Electric & Manufacturing Company.

These run at about 325 revolutions per minute and being 22-pole machines the alternating current has a frequency of about 60 cycles per second. The current is generated at a pressure of 500 volts. The two alternators are always run in multiple, feeding into the same bus-bars on the switchboard as shown in Fig. 5. The total output of the station is recorded by two Shallenberger integrating wattmeters, one placed in each phase (Figs. 4 and 5). As indicated in Fig. 5 the entire current passes through the primary of a series transformer, the secondary of this transformer being connected to the wattmeter. The general plan of the transmission of the power to Hartford and of its distribution and of its utilization is shown in Fig. 2. The current from the generators passes to four step-up transformers each having a capacity of 300 kilowatts and two being connected in multiple on each phase of the system. The switches are arranged so that either bank of trans-

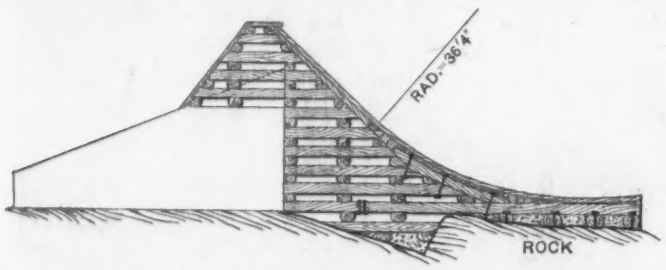


FIG. 3.—CROSS-SECTION OF DAM AT FARMINGTON RIVER.

formers can be cut out of service in case only one alternator is in use. The transformers, two of which appear in Fig. 4, are of the oil insulated type. They are so constructed that the oil has an especially large radiating surface and so designed that the oil is continuously in circulation. By means of these transformers the voltage is raised from 500 to 10,000 volts, and at the same time the current is changed from two-phase to three-phase by the well-known method suggested by Mr. C. F. Scott, (see Fig. 5). No attempt is made to handle the 10,000-volt circuit by means of switches.

The current from the transformers is transmitted to Hartford over six No. 0 wires, two being connected in multiple on each phase; six wires were used instead of three, simply because this arrangement allowed the lines used in the former transmission to be adapted to the new conditions more economically. The wires are supported on double petticoated glass insulators. When within 3000 feet of the Pearl Street station the wires are taken underground and connected with three No. 0000 cables which lead to the station. This underground line, connected to more than 10 miles of overhead line, has now been in operation continuously for about four months with perfect success. The lines are protected from lightning by banks of Wurts arresters and choke coils. These arresters are mounted in racks as shown in Fig. 6. One rack of arresters is placed in each phase of the circuit at each end of the line. The arresters at the Farmington River are in a special building just outside of the station; those at the Hartford end of the line are placed in the man-hole where the overhead joins the underground system, the man-hole being specially designed for the purpose.

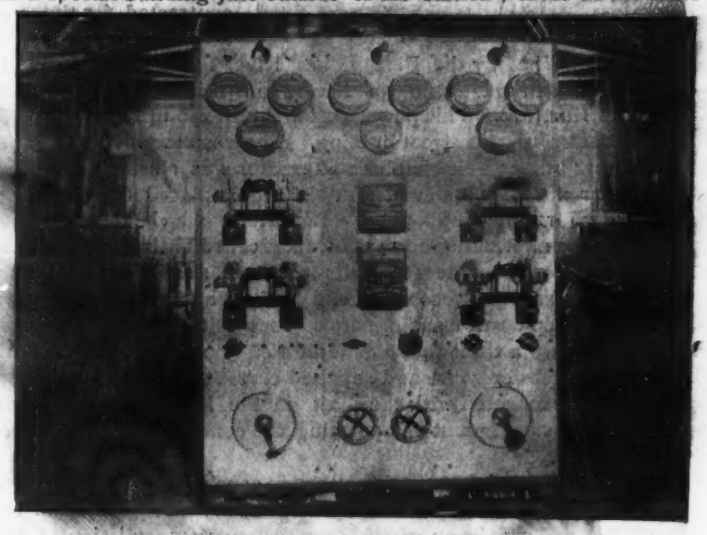


FIG. 4.—SWITCHBOARD AT POWER STATION.

The pressure at Hartford is reduced to 2400 volts and changed back from three-phase to two-phase by step-down transformers (Fig. 9). The three-phase system was used on the long-distance line owing to the better efficiency of that method of transmission. The two-phase system of distribution was preferred, as it was considered easier to adapt it to the existing single-phase lines.

Although all recent distribution of the alternating system is under a pressure of 2400 volts, it was considered advisable to continue, for a time at least, the 1200-volt circuits, and consequently the transformers were designed so that they could also supply this voltage. This is accomplished (Fig. 9) by bringing out a connection from the middle of the secondary of the transformer. The transformers are in other respects similar to those at the Farmington River, and of the same capacity.

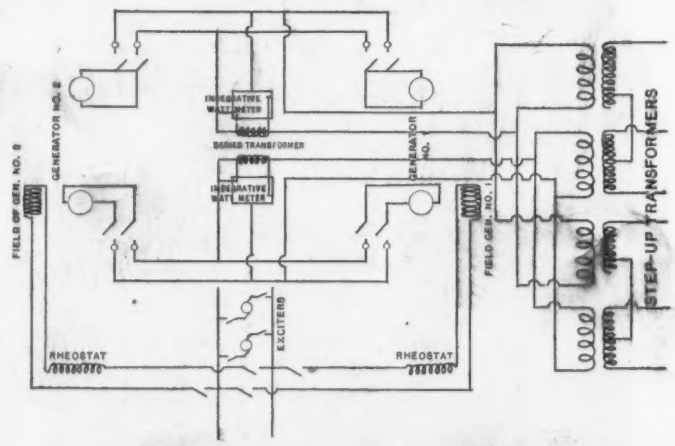


FIG. 5.—DIAGRAM OF CONNECTIONS AT POWER STATION.

The electric energy received at the Pearl Street station is used for three purposes. It supplies the current to all the alternating-current lighting and power system; it supplies the current to the rotary transformers at the State Street station for charging the storage battery and for supplying current directly to the three-wire-direct current system; what is not used for these purposes supplies the

power to operate a 600-kw synchronous motor, directly connected to the line of shafting at Pearl Street. In the alternating-current distribution, as indicated in Figs. 2 and 9, circuits are run at 1200 volts on the single-phase for supplying lights as well as at 2400 volts on the two-phase system for supplying lights and power. The reason for running some single-phase circuits at 1200 volts was to render possible the continued use of the old transformers. No great difficulty has been experienced in balancing the circuits sufficiently to make the distribution on the system as described completely satisfactory.

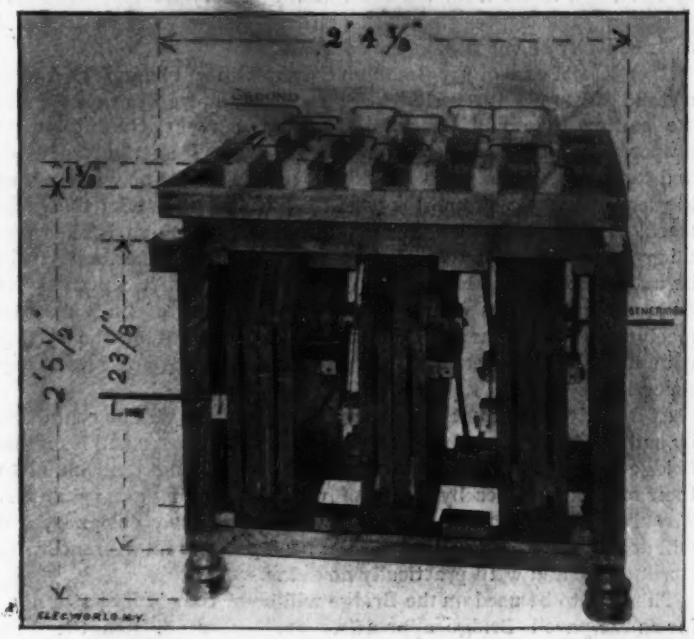


FIG. 6.—RACK OF LIGHTNING ARRESTERS AND CHOKE COILS.

When the recent changes were made the frequency was reduced from 133 to 60 periods per second. The only serious trouble experienced from this change was the burning out of a few transformers of one of the older types of construction. Switches on the Pearl Street switchboard Fig. 7, are of the plunger type, and so constructed that when operated a double break is made in each line. The connections and switches are arranged to permit of any single-phase lighting circuit being supplied from either phase of the two-phase system.

The synchronous motor, Fig. 8, is direct-coupled to one end of the line of shafting in the Pearl Street station—a 1000 and a 600-hp Cooper-Corliss compound-condensing engine being belted to the

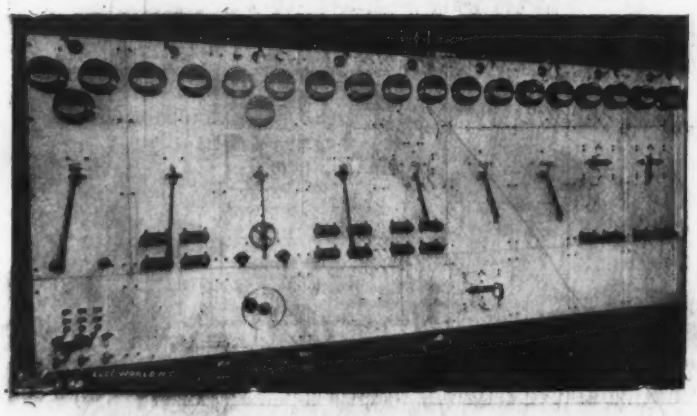


FIG. 7.—SWITCHBOARD AT PEARL STREET STATION.

other end, the condensation being in part produced by water from artesian wells and in part by the use of a Worthington cooling tower. It is so arranged that the motor or either of the engines can be disconnected from the shaft.

The series-arc dynamos and two 200-kw street railway generators that supply power to one of the suburban street railways are operated from this line of shafting.

The synchronous motor can operate not only as a motor, but also, when supplied with power by the engines, acts as a generator and supplies current to the alternating system. As shown in Fig. 9, the motor is always connected with the bus-bars of the switchboard, so that whenever the load on the alternating system exceeds the capacity of the water-power, as frequently occurs during the hours of maximum load, the motor immediately becomes a generator driven by the engines and supplies current in multiple with the generators at the water-power. The motor also answers as a spare generator to be run by power supplied by the engines in case of shortage of water or trouble with the transmission line.

The synchronous motor gives the switchboard attendants at Pearl Street a means of varying the voltage on the alternating system in-

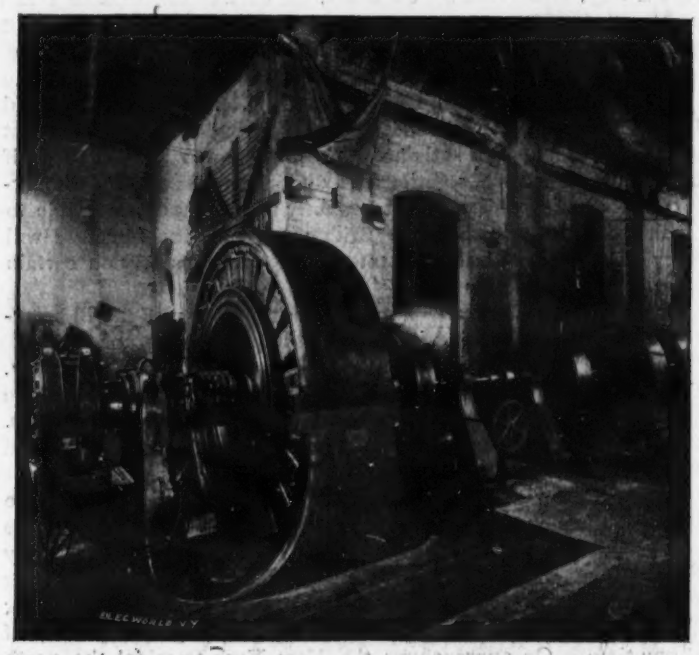


FIG. 8.—SYNCHRONOUS MOTOR AT PEARL STREET STATION.

dependently of the power station. It is possible to change the voltage through a wide range by varying the field excitation of the motor. This is accomplished by introducing a lagging current into the transmission line, and this method is consequently only applied in changing the voltage through small ranges.

The synchronous motor is started by means of an induction motor (Fig. 8) which is disconnected from the circuit as soon as the synchronizing speed is obtained. When starting the shafting is disconnected from the motor. The motor is constructed to work at a pressure of 2400 volts, so that no special transformers are needed when it is operated as a generator. Five-hundred-volt generators were preferred at the power station, as the type of armature construction used in these was considered better than that used in 2400-volt generators.

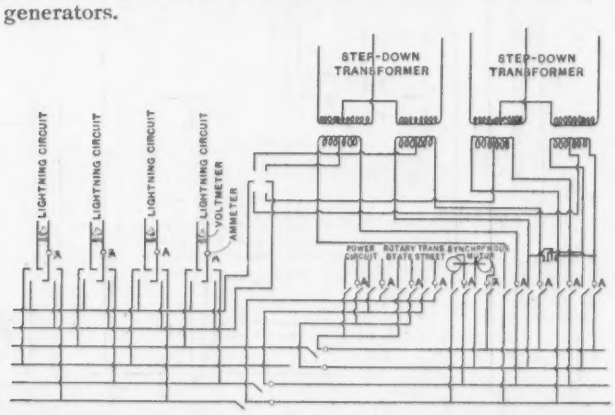


FIG. 9.—DIAGRAM OF CONNECTIONS AT PEARL STREET STATION.

All three machines have slotted armatures and are wound with progressive winding. The armature windings of the 500-volt generators are built up of copper bars. Owing to the increased number of turns necessary on the 2400-volt generator its armature is wound with wire. Protection from overloads on the alternating system is afforded by fuses, made of thin strips of aluminum enclosed between two tightly fitting blocks of *lignum vitæ*, placed on the lower part of the alternating-current panels of the switchboards (Figs. 4 and 7). An opening in the outer block allows the expansion of air in case the fuse blows.

(To be continued.)

Electric Surface Lines and Elevated Trains on the Brooklyn Bridge.

At the meeting of the Bridge Trustees, held on Feb. 8, was presented the report of the commission of three experts appointed to investigate the feasibility of running elevated trains and surface cars over the Bridge. The experts are Messrs. Virgil G. Bogue, George H. Thomson and Leffert L. Buck, and they conclude that from an engineering or operating point of view there is no adequate reason why, under suitable contracts, the cars of the surface roads and the trains of the elevated railways, or either of them, should not be permitted to operate on the Bridge.

The plans for the proposed improvements as far as they relate to the surface cars were designed by Messrs. J. C. Brackenridge and D. F. Carver, and the commission in referring to them state that they are ingenious and satisfactory, and to their minds the best, if not the only workable, solutions of a difficult problem. The commission states as its opinion that it is wholly feasible and practicable to operate the surface cars on the Bridge and that the structure will carry the additional load presented with perfect safety on certain prescribed conditions.

By referring to the accompanying diagrams the reader will be enabled to better understand the proposed improvements.

There are two tracks crossing the Bridge, one on each roadway. The tracks will be laid on the outer edge of each roadway, and the clearance between the widest cars and the outside truss is 11 inches. There will be a clearance of 10 feet on each roadway for wagons and other vehicles.

An elaborate system is provided at the New York terminal, the object of the plan being for the cars coming in from Brooklyn, to pass around the New York station on a loop and continue their way to Brooklyn on the opposite side of the Bridge, after having discharged their New York passengers and taken on those for Brooklyn. They will therefore not leave the Bridge structure itself at any time. On approaching the New York terminal the north track at a point 365 feet from the east end of the station will begin an ascent on a grade of 4 per cent. This grade will continue for 185 feet in order to allow headway for the passage of trucks, wagons, etc., underneath. The elevated structure will then run on a level for 100 feet, then descend on a 4 per cent. grade for 133 feet in order to clear the roof girders of the station. At the end of this 4 per cent. grade it reaches a level that is two feet higher than that of the existing Bridge tracks in the terminal building. From this point it continues for 210 feet on a level, and then ascends a grade of 5 per cent. to a distance of 260 feet, where a half circle begins which has a radius of 57½ feet and which loops around the west end of the terminal building, but above and entirely clear of the Manhattan elevated railway station on Park Row and of the switching tracks of the Bridge railway, leaving a clear head room for the cars of the latter of 15 feet. The loop joins the track of the north side with that of the south side so as to make them continuous. Twenty-two sidings are provided.

All the tracks of the terminal rest upon floors of solid construction, which provide the necessary platform areas for discharging and receiving passengers. The whole is enclosed by extensions or balconies of the main building, which with the track floors and platforms are supported on columns.

There are 14 stairways provided to reach the passenger platforms of the track floors from the level of the gallery floor of the main building. The aggregate width of these stairways is 64 feet, and their capacity 60,000 people per hour.

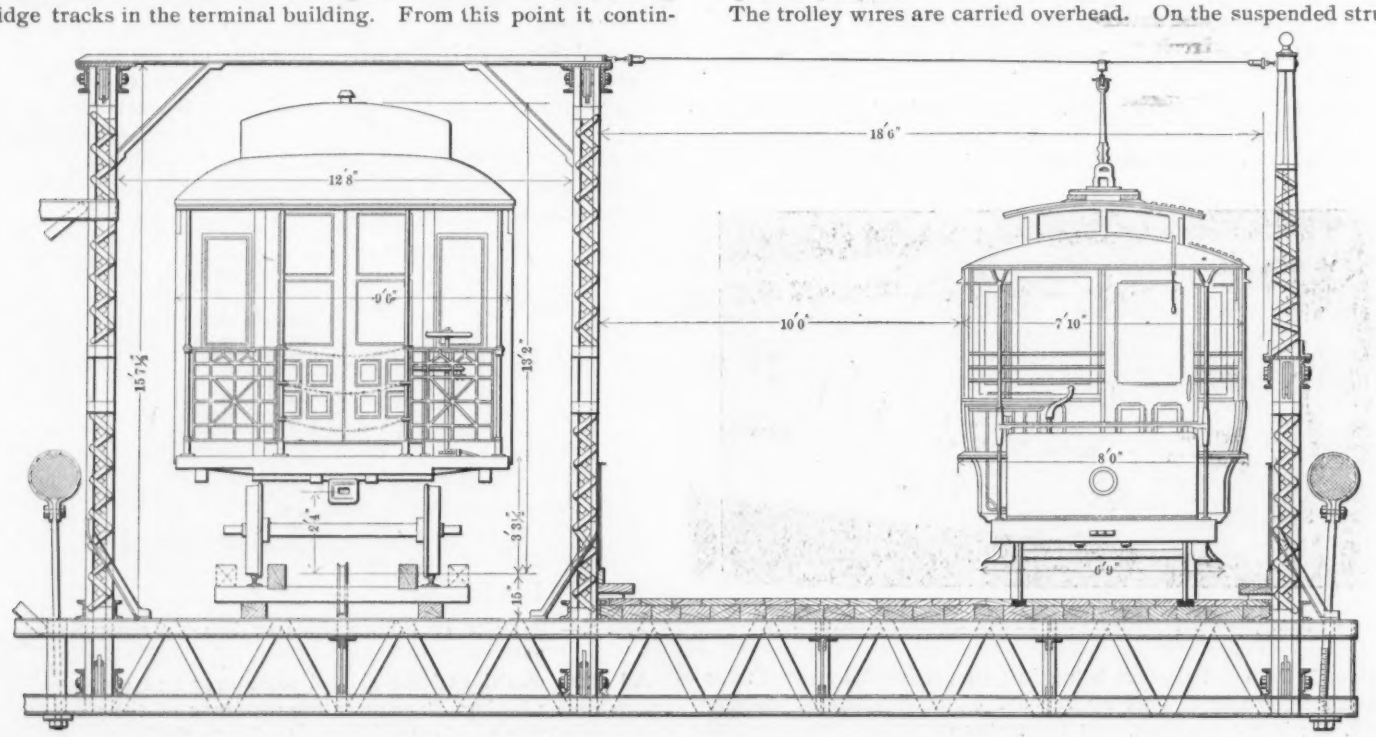
Each line of cars of the Brooklyn City system will be provided with a stand of its own at the New York terminal, and as the cars enter the station they will be shunted from the main track to their proper siding, where the passengers will leave from the front end, and those desiring to go to Brooklyn over the same line will enter at the rear door. On signal, the car will proceed and take the main track, pass around the loop and continue on to Brooklyn. The same thing is done in the case of the cars of the different lines, and it will be understood from a little study of the diagram of the plan of the sidings that the cars of one line or any number of lines may be receiving and discharging passengers at any point of the system without any interference whatever with the passage of cars of any other line.

At Brooklyn the street surface and Bridge tracks will be connected by suitable curves, and all the surface cars will enter and leave the Bridge at Sands Street, those for Brooklyn being distributed to their respective lines by means of proper switching arrangements. The Brooklyn terminal plans are very ingeniously designed, and will accomplish the results with the least possible interference with street traffic and with practically no delay.

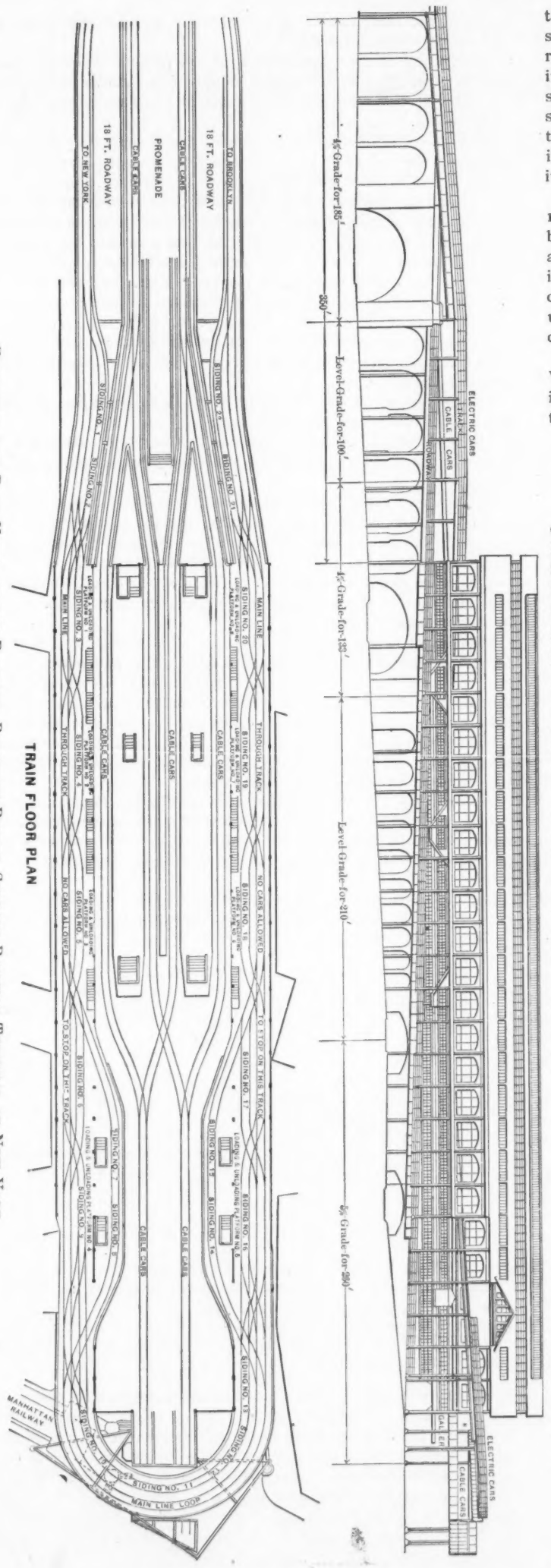
The rails to be used on the Bridge will be of the girder pattern as far as the paved Bridge approaches are concerned. On the suspended structure the rails are flat, with surface or tread flush with the surface of the roadway, have a groove for the flange of car wheels, and their weight is 60 pounds to the yard. They rest upon the lower four-inch layer of roadway plank and are of a pattern especially rolled for use on bridges. By referring to the half cross sectional view of the Bridge the form of these rails will be seen. The rails of the New York terminal are of the T-type and weigh 60 pounds per yard.

The trolley wires are carried overhead. On the suspended structure one end of each of the span wires which supports the trolley wire is attached to the top cord of the inner truss, while the other end is secured to the top of an iron or steel post which rests upon and is fastened to the top cord of the outer truss, all being well insulated.

At the New York end a number of switches of recent design are



HALF SECTION SHOWING SURFACE CAR ON ROADWAY OF BROOKLYN BRIDGE.



ELEVATION AND PLAN VIEWS OF THE PROPOSED BROOKLYN BRIDGE SURFACE RAILWAY TERMINAL AT NEW YORK.

to be placed where required. The terminal is to be operated from a signal tower located probably over the central tracks of the Bridge railway where the best view of the interior of the train shed and of its tracks may be obtained. If, by chance, one car of one line should be followed immediately by another car of the same line, the second car would run to a lay-over siding where it would wait until the first car had started for Brooklyn, when it would also, on receiving the proper signal, run to its own siding, discharge and receive its passengers and be dispatched to Brooklyn.

Under the proposed plans the traveling public will be divided into 14 small bodies instead of being handled in a compact mass, there being 14 stairways and platforms for the various car stands. Signs and pointers located in conspicuous places will direct people unfamiliar with the surroundings to the platforms and cars they seek. It is claimed that one minute will be ample time for a car to load and unload its passengers at each of the 14 sidings. In other words, 14 cars per minute can be received from and despatched to Brooklyn.

The report was referred to a committee consisting of Mayor Wurster, of Brooklyn, Comptroller Palmer and Mr. Henriques, with instruction to report at a special meeting of the board to be held on the afternoon of Feb. 16.

The Chambley Rapids Montreal Power Transmission.

The power transmission plant now being built under the supervision of the Royal Electric Company, of Montreal, at the Chambley Rapids of the Richelieu River, about 16 miles east of Montreal, will involve several rather novel features, the one of chief significance being the generation of the transmitting energy at the line potential of 12,000 volts without the use of step-up transformers. As this plan would hardly be considered feasible with any type of generator except an induction alternator, this plant is likely to prove the forerunner of many large electric power transmission plants in the future in which the indisputable advantage of using a generator containing no moving conductors is combined with the evident saving in first cost due to avoiding the use of step-up transformers. Each unit in this plant will consist of a 2500-hp "S-K-C" two-phase inductor generator and two 48-inch twin Victor turbines, all on one horizontal shaft. It is expected that when each turbine is provided with the latest type of Stillwell-Bierce gate regulator any or all of the eight generators may be coupled in parallel without danger of excessive idle currents or unequal distribution of load. The determination by actual test of the practicability of so operating will be watched with interest by all who have to deal with high potential multiphase systems which depend on water power. But when it is remembered that each generator has an enormous fly-wheel regulation, resulting from the great mass of the iron inductor fourteen feet in diameter, and that in addition to this the generators have no compound winding to increase the surging effect of the idle currents, and yet have an inherent regulation of 4 per cent., it appears that the designers of the plant have good ground to expect to obtain satisfactory working results by the means chosen.

Electric and Light Oscillations.

According to the Austrian physicist Puluj, the oscillations from a Leyden jar are from 100,000 to 1,000,000 per second, depending on its size, but in order that the electric rays produced thereby should become visible as red light the number of oscillations would have to be increased to 400,000,000,000. A tuning fork which makes 1000 vibrations per second would have to vibrate 12,000 years before it would make 400,000,000,000 oscillations.

An Epidemic in Rays.

According to the Vienna correspondent of a London paper, Prof. Friedrich stated at the Vienna Academy of Sciences that he had discovered a new species of rays which show definitely whether death has taken place; pictures taken on photographic plates differ according to whether the body traversed is dead or living.

Carborundum.

According to Fitz Gerald, one pound of carborundum requires about seven-hp hours for its production.

Luminous Efficiency of the Alternating-Current Arc.[1]

BY A. E. BLONDEL, ASSISTED BY E. JIGOUZO.

In a former work, presented nine months ago to the Congress of the French Association for the Advancement of Science, we made known the results of a research upon the efficiency of the continuous-current electric arc. The object of the present note is to set forth the first results of an analogous study of the alternating-current arc.[2] The latter should present much more interest because little up to the present time has been made known regarding the photometric value of this arc. The greater part of those who have employed it agree in finding it notably inferior to the continuous-current arc, and Prof. Silvanus Thompson,[3] who seems to be facetious, alone claims that, the energy being transformed in the two cases following analogous conditions, the efficiency should be the same. The authors are no longer in accord, however, when it comes to fixing the value of the ratio. According to Prof. Fleming and M. Petavel,[4] the difference is almost 100 per cent. in favor of the continuous-current arc; according to Profs. Wedding and Rössler[5] it exceeds 150 per cent., while, on the contrary, the Frankfort Commission evaluates it at no more than 25 per cent.

This uncertainty is due to two causes; one the complete absence of precision in the methods employed in photometry for the measurement of the mean spherical intensity; the other, the absence of coordination between the data of operation of the area observed. It is thus that in some of the best works that have been published on this subject experiments made with arcs varying from 0 to 7 millimetres have been used in the construction of one and the same curve of efficiency relative to the energy consumption, without taking into account the enormous variations of light produced by a small variation in the length of the arc. In the present work these sources of error have been as far as possible avoided.

On the one hand, care has been taken to make several series of measurements rationally classified according to the diameter of the carbons, the intensity of the current, the difference of potential between the terminals, the nature of the carbons, etc. On the other hand, the measurements have been rendered at once precise and rapid by the employment of the *lumenmètre*, invented two years ago by the author,[6] which gives the mean spherical intensity *by a single measurement.*

Thanks to this instrument it has been possible to greatly multiply the measurements; each of the figures which have served to determine the curves given below is the mean of from 10 to 20 readings made at close intervals and which generally are in accordance to within less than 10 per cent., and some within 5 per cent.

Efficiency has been defined as "*the ratio of the total light produced to the energy absorbed.*" This light is entirely utilized for the illumination of rooms; but for the lighting of uncovered areas the luminous flux emitted above the horizontal plane is lost, but can be recovered almost entirely by the employment of a helios reflector or a dioptric holophane apparatus. Under these conditions about 90 per cent. or more of the total light may be utilized. This is therefore the proper quantity to measure.

All the measurements have been reduced to the units adopted by the Congress of Geneva, and particularly to the "*lumen*" and to the *bougie décimale*," which, for simplicity of writing and to avoid all errors, will be distinguished here by the name "*pyr.*"

It will be remembered that the pyr, or bougie décimale, is the twentieth part of the Violle unit, and is sensibly represented by the Hefner standard. The lumen is the luminous flux emitted by a source of light of one pyr through a spherical angle equal to one steradian.[7] The only difficulty was to compare the bluish light of the arc with the reddish light of the Hefner standard; there may arise from it a slight uncertainty as to the absolute value of the results, but not as to their relative values, for care was taken to employ as a comparison lamp throughout all these experiments a source of the same tint as the arc (obtained by placing properly colored papers before a Hefner lamp.)

The details of the organization of the experiments which have been sufficiently described in the memoir cited above, will not be entered upon here, but only the results of these researches will be made known.

Results.—To facilitate the comprehension of these they are plotted as curves, the ordinates of which are proportional to two different scales, either of which may be employed as preferred, the right hand side giving the luminous flux, and the left the corresponding mean spherical intensities; when a reflector is employed, as mentioned above, it is necessary to multiply the first numbers by about 0.9 and the second by about 1.80 to obtain the *hemispherical* intensity.

The carbons used were those marked "Nanterre" (made by the Société Française des charbons pour l'électricite) and those marked "Helios" from the Helios Company, of Cologne. They were furnished gratuitously for these experiments by the two companies.

The numbers placed near the curves indicate the lengths of the arcs in millimetres.

The results permit the exhibition of the influence upon the efficiency of the following different factors:

Diameter of the carbons; distance between the carbon points; nature of the carbons; form of the alternating-current curve and the frequency.

Influence of the Diameter of the Carbons.—The influence of the diameter of the carbons is the same as for the continuous-current arc; that is to say, an augmentation of the diameter reduces in an enormous proportion the luminous efficiency obtained.

This effect is well seen in Fig. 1, which shows that carbons of 14 mm diameter in place of those of 10 mm give only a flux of 3600 lumens instead of 4500.

This effect shows itself in all the other curves, but it is unfortunate that one cannot give a mathematical expression to this law; it is true that certain authors, particularly Schreihage, have thought it could be expressed by saying that the luminous intensity is inversely proportionate to the diameter, but unhappily this law is not verified by the results herewith given, and it unfortunately takes no account of the enormous influence of the *distance* between the carbons, of which we will now speak.

Influence of the Distance Between the Carbon Points.—The influence of the distance between the carbon points is measured at the same time as that of voltage in determining the total luminous flux produced under constant current and various tensions at the terminals.

Figs. 1, 2 and 3 show curves thus obtained. In Fig. 2 the distance between the points is indicated in millimetres. It is seen that with

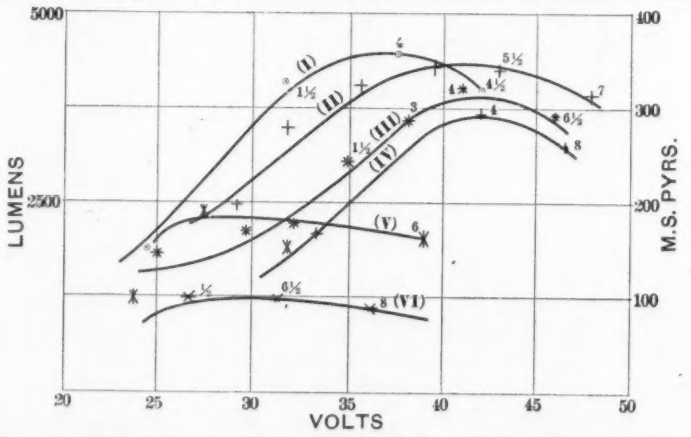


Fig. 1.—Variations in Luminous Power with Diameter of Carbons and Length of Arc for Nanterre Carbons; 10 Amperes; Sensibly Sinusoidal Current Wave.

Curves I, II, IV and VII are for homogeneous lower carbons; Curves V and VI for both carbons cored. The diameters of carbons are: 10—10 for Curves I and V; 14—14 for Curves IV and VI; 12—10 for Curve II; 14—12 for Curve III; 12—12 for Curve VII.

the distance increasing, the flux at first augments to a maximum and then decreases in turn very quickly. It is necessary then to avoid increasing the distance between the points too much if a good efficiency is desired. The point of maximum efficiency on each curve corresponds to the point of tangency of this curve, and a right line drawn through the origin (0 lumen, 0 volt), since the efficiency is the ratio of the flux to the energy (here proportional to the tensions, since the current is constant). In fact, this point differs but little from the highest point of the curve.

[1] Extract from a forthcoming and more complete publication upon the efficiency of the electric arc.

[2] This research was executed in the Laboratoire Central d'Electricite at Paris, thanks to the hospitality of the Société Internationale des Electriciens.

[3] "Lectures on the Electric Arc," 1896.

[4] *The Electrician*, Dec. 20, 1895.

[5] *Electrotechnisches Zeitschrift*, Aug. 22, 1895, p. 349. See also the interesting communication of M. Görges, in *Electrotechnische Zeitschrift.*

[6] *Comptes Rendus* de l' Acadèmie des Sciences, 1895. Bulletin de la Société Internationale des Electriciens, 1895, etc.

[7] Compare the interesting communication of Prof. Macfarland to the Am. Inst. of Electrical Engineers, 1895.

Influence of the Nature of the Carbons.—These curves show that according to the nature of the carbons, the most advantageous distance between the carbon points is different, and that the voltage corresponding to the maximum efficiency is still more variable from one quality of carbon to another.

We have used four principal types of carbons: Carbons from the Helios Company, of Cologne; ordinary carbons from the Nanterre Company; carbons from French lighthouses marked *Nanterre*, and carbons from French lighthouses marked *Carré*.

The first two products, which are industrial varieties, show their

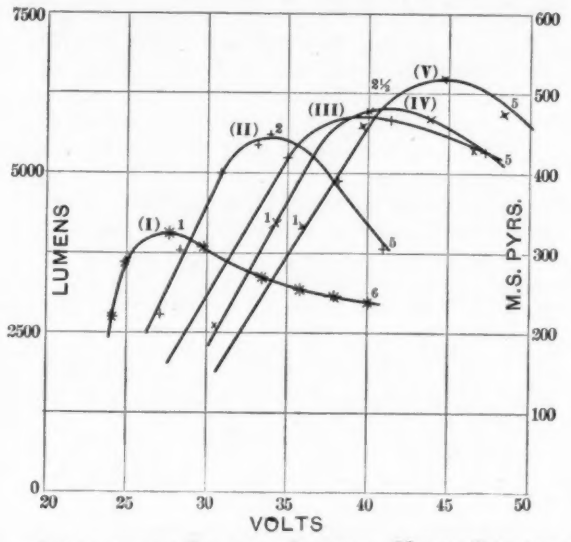


FIG. 2.—ANALOGOUS TO FIG. 1. 10 AMPERES; HELIOS CARBONS 10—10.
Curves I, II and IV for cored carbons; Curves III and V for upper cored and lower solid.

maxima at about 28 volts; the other two at about 32 and 40 volts respectively.

The ordinary Nanterre carbon, according to Fig. 2, gives only about two thirds the flux of the Helios carbons for equal expenditure of energy.

The Nanterre lighthouse carbons consume more, but also give more light, so that their efficiency per watt is at least as high as that of the Helios. Fig. 4 shows the efficiencies in candle-power per watt for three qualities—Helios, Carré and Nanterre lighthouse. The latter is the most excellent, from this point of view; but these

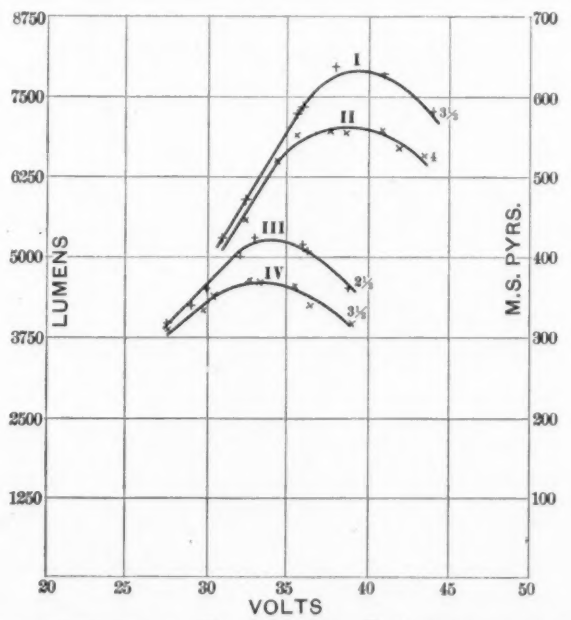


FIG. 3.—INFLUENCE OF VOLTAGE AND FREQUENCY AT THE TERMINALS; 10 AMPERES; DIAMETER OF CARBONS, 10 MM. RECTANGULAR CURRENT-WAVE.
Curve I, Nanterre Lighthouse Carbons, 27 ∽; II, same at 189 ∽; III, Helios Carbons, 23 ∽; IV, same at 162 ∽.

carbons frequently scale and point less well than those marked Helios. We therefore designate here only the photometric values established in our memoir without wishing to select any industrial consequence.

Influence of the Core.—It is a very curious fact that in the case of low-voltage carbons, such as the Helios and the Nanterre, a much better efficiency is obtained from a homogeneous lower carbon than by employing cored carbons. This fact is very clearly put in evidence in Figs. 1 and 2. In the first it is seen that the efficiency is easily doubled with Nanterre carbons of 10 mm diameter, and almost tripled with carbons of 14 mm diameter, by the simple substitution of a homogeneous for a cored carbon.

With high voltage carbons of the lighthouse, Nanterre, and Carré types, this effect no longer so clearly exists. The employment of a homogeneous carbon augments the flux considerably, but increases the consumption of energy at the same time, so that the efficiency remains about the same. It is, in fact, as we have shown in a

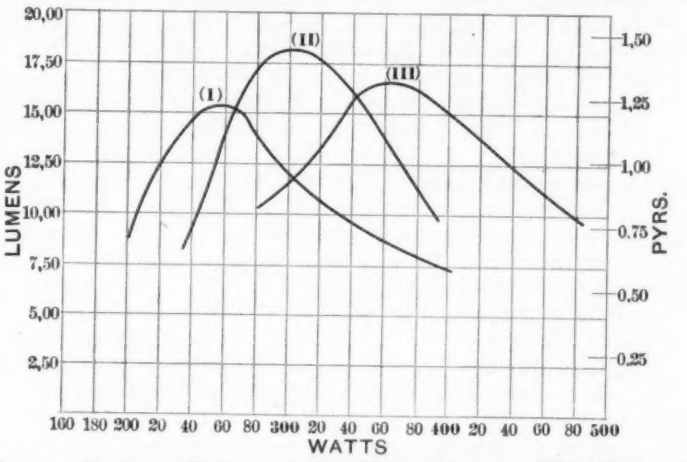


FIG. 4.—MAXIMUM EFFICIENCY PER WATT OBTAINED WITH VARIOUS CARBONS FOUND BEST FOR THE MAXIMUM PRODUCTION OF LIGHT. DIAMETER OF CARBONS, 10 MM; 10 AMPERES.
Curve I, Ordinary Helios; Curve II, Nanterre Special Lighthouse; Curve III, Special Carré.

former work. These carbons are hard-cored and give very good arcs, whereas the low voltage carbons have such soft cores that they do not permit the establishment of a true electric arc, but only a sort of mixed incandescence at a much lower temperature.

Following these convincing measurements, the employment of a homogeneous lower carbon has been adopted for the lighting by alternating currents of the Avenue de l' Opera in Paris, and gives great satisfaction. It is, in a general way, to be recommended.

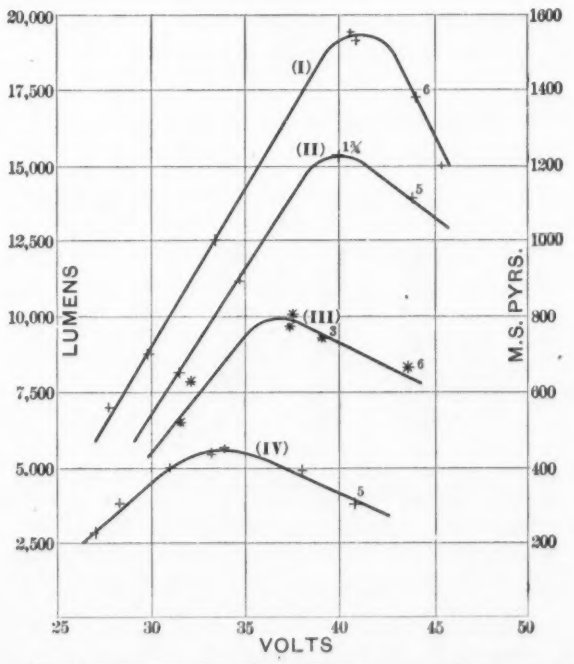


FIG. 5.—VARIATIONS OF LUMINOUS POWER AS A FUNCTION OF THE CURRENT FOR NANTERRE LIGHTHOUSE CARBONS OF 10 MM UPPER CORED; LOWER HOMOGENEOUS; VARIABLE VOLTAGE.
Curve I, 25 Amperes; II, 20 amperes; III, 15 amperes; IV, 10 amperes.

Good alternating arcs cannot be obtained with two homogeneous carbons, at least with those that are used in Europe. In all cases the photometric measurements have shown that they give inferior results to the cored carbons.

(*To be continued.*)

Alternating-Current Machinery.—IV.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

Chapter IV.

SIMPLE-HARMONIC E. M. FS.

WHENEVER a movement of magnetic flux or magnetism takes place through space, or, whenever, independently of motion, the strength of the magnetic flux increases or diminishes, E. M. Fs. are produced in the neighborhood of the flux. If these E. M. Fs. be produced in a conductor, they may be employed for the production of electric currents in the conductors. Thus, if we move a conductor, such as a wire, through a region traversed by magnetic flux or magnetism, an E. M. F. will be developed in the conductor, along its length, during the motion across the flux; or, if the conductor remaining at rest, the magnetic flux be moved across it, an E. M. F. will be induced in the conductor in like manner.

29. Fig. 19, represents an electromagnet maintaining a magnetic flux between its pole pieces N and S. A plan view of the magnet is shown at A, and an elevational cross-section at B. A wire $w\ w$, is placed between the poles so as to lie across the direction of the magnetic flux. So long as the conductor remains at rest relatively to the steady magnetic flux, no E. M. F. will be induced in it. If, however, the wire be moved downwards, as indicated by the arrow at B, an E. M. F. will be induced along the wire in the direction of the arrows shown at A, so long as the motion takes place through the magnetic flux. Reversing the direction of the wire's motion, as moving it in the opposite direction to the arrow at B, will induce, during the motion, an E. M. F. in the opposite direction to the arrows at A. Similarly, if the wire remain at rest, but the magnet with its flux be moved upwards, the E. M. F. induced by and during motion will be in the direction shown at the arrows at A; while, if the magnet be lowered, the E. M. F. induced will have the opposite direction to the arrows at A.

30. The magnitude of the E. M. F. induced in a given length of wire will depend upon the rate at which the wire cuts magnetic flux. If the wire has such a length, and moves with such a velocity, that its rate of cutting magnetic flux is, say, 500,000 webers, or C. G. S. units, of magnetic flux per second, the E. M. F. induced in the wire

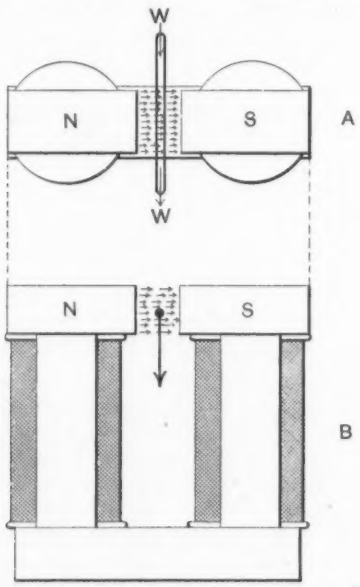


Fig. 19.—E. M. F. Induced in a Wire by its Relative Movement to Magnetic Flux.

at that moment will be 500,000 C. G. S. magnetic units; or, since 100,000,000 C. G. S. magnetic units of E. M. F. are equal to one volt, the E. M. F. at that moment will be $\frac{500,000}{100,000,000} = 0.005$ volt.

31. In order that a current may flow steadily through a conductor, it is necessary to form a closed conducting loop, or to join its ends together. The E. M. F. generated in the loop by the relative motion of the edges of the loop, and the magnetic flux in its vicinity, will be the sum of the rates of cutting magnetic flux taken all around the loop, with proper regard to sign, and this summation will evidently be the rate at which magnetic flux is being added to the loop. Consider a loop of conductor AB, Fig. 20, placed in a uniform magnetic field with its plane perpendicular to the direction of magnetic flux. Then, if the flux remains constant in intensity, no E. M. F. will be induced in the loop, so long as it remains at rest. If we cause the loop to move in a direction in its own plane, say in the direction from A towards B, with any velocity, the total E. M. F. induced in the loop will be zero, because the advancing edge B, produces an E. M. F. counter-clockwise around the loop, as viewed by the observer, while the following edge A, produces an equal and oppositely directed, or clockwise E. M. F.; so that these two necessarily neutralize each other. It is also evident that no difference exists in the total amount of flux passing through the loop, since as much flux enters it at the advancing edge B, as leaves it at the following edge A. If, however, the loop be supposed to advance towards a region where the flux is more dense, while still retaining the same direction, an E. M. F. will be induced in the loop. This may be accounted for, either by regarding the cutting of the advancing edge as being greater in the more dense flux than at the following edge, whereby a differential development of E. M. F. takes place; or that the loop contains an increasing quantity of magnetic flux. Similarly, if the loop moves toward a region where the flux is less dense, there will be an E. M. F. induced in it as a whole, and this may be considered either as due to the outstanding sum of the rates of cutting of different portions of the loop taken all around; or as to the diminution in the quantity of flux contained.

32. If the quantity of magnetic flux contained inside a conducting loop is Φ webers, the E M. F. induced in the whole loop, expressed in C. G. S. units, will be the rate of change of Φ, with time, or its time-rate of change; that is the instantaneous rate of adding to or diminishing Φ. If in a given very small interval of time, represented by dt, the change in the quantity of enclosed magnetic flux is $d\Phi$, the E. M. F. induced during the interval dt, will be $\frac{d\Phi}{dt} = e$ C. G. S. units. The direction of the E. M. F. will depend upon the sign of $d\Phi$. If Φ, increases, $d\Phi$, will be positive, and the E. M. F. e, will be positive, if, on the contrary, Φ, is diminishing, $d\Phi$, will be negative and e, will be negative. Moreover, if the flux be removed and reversed in direction, the E. M. F. will be reversed in direction.

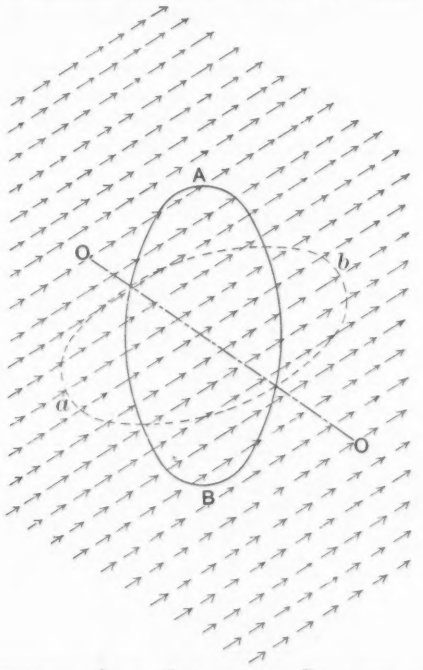


Fig. 20.—Conducting Loop Capable of Rotation in a Uniform Magnetic Field.

33. If we assume arbitrarily one face of the loop AB, as the positive side, say that facing b, in Fig. 20, then the E. M. F. induced in the loop, as a whole, will be counter-clockwise, or negatively directed around the loop, when the flux enters or fills the loop in the direction toward b, as shown by the arrows. Consequently, if a loop be regarded as the rim of a clock dial, and the magnetic flux enters the loop in the same direction as the rays of light coming from the dial to the observer's eye, the E. M. F. induced in the loop will have the same direction around it as the hands of the clock.

34. There are three ways in which an E. M. F. may be induced in a conducting loop.

First: By moving it in its own plane from regions in which the

magnetic flux varies in intensity; or, still more effectively, varies in direction.

Second: By moving the loop about an axis; *i. e.*, rotating it in a magnetic flux which may either be uniform in strength and direction, or not uniform.

Third: By varying the strength, or still more effectively by varying both the strength and direction of the magnetic flux, leaving the loop at rest.

The first two methods of inducing E. M. F. are adopted in alternating-current generators, while the third is the method adopted in alternating-current transformers.

35. In each case, since the E. M. F. in the loop does not depend upon the total quantity of magnetic flux enclosed, but only upon the time-rate-of-change of this quantity, it is evident that, so far as the loop itself is concerned, the E. M. F. induced by any succession of cyclic movements must be alternating in direction; for, so long as the magnetic flux threading through the loop is increasing, the E. M. F. has one direction and since this magnetic flux must be removed from the loop after it has all entered, the E. M. F. during the process of removing must be oppositely directed. In other words, the only known way of inducing an E. M. F. in a loop of wire, by a succession of cyclic movements through magnetic fields, is first to fill the loop and then to empty it, thereby producing alternations of E. M. F.; although the manner in which the filling and emptying takes place may vary in an infinite variety of ways, with a corresponding variety in the generated E. M. F.

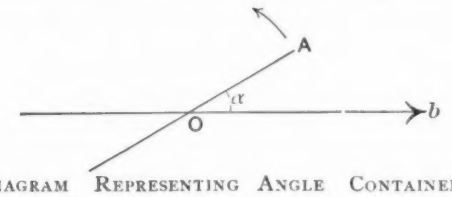


FIG. 21.—DIAGRAM REPRESENTING ANGLE CONTAINED BETWEEN REVOLVING LOOP AND THE DIRECTION OF THE MAGNETIC FLUX.

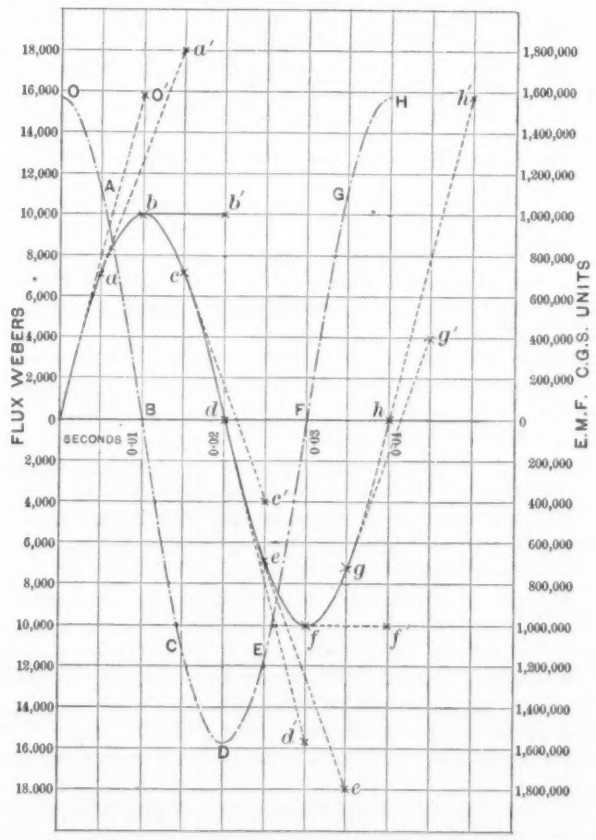


FIG. 22.—CONSTRUCTION OF A SINUSOID REPRESENTING RATE OF CHANGE OF A SINUSOID.

36. In Fig. 20, let OO, be an axis at right angles to the magnetic flux, about which the loop AB, may be revolved. In the position AB, the magnetic flux contained within the loop is a maximum, while in the position ab, when the plane of the loop coincides with the direction of magnetic flux, the magnetic flux contained within the loop will be zero. This is also represented diagrammatically in Fig. 21, where OA, represents the position of a loop revolvable about the axis O, and α, the angle of AOb, which the loop makes with the direction of the magnetic flux Ob. If A, be the area of the loop in square centimetres, and $\mathfrak{B}$, be the uniform intensity of magnetic flux expressed in webers-per-square-centimetres, or *gausses*, the total quantity of flux Φ, contained in the vertical position AB, will be $\Phi = A\mathfrak{B}$ webers. In other words, when $\alpha = \pi/2$, ($\sin \alpha = 1$) the flux enclosed $= \Phi$, when $\alpha = O$, the flux enclosed $= O$. From this it will be seen that the projection of bOA, upon a plane perpendicular to ob, determines the virtual area of the ring for the admission of magnetic flux, so that this virtual area varies with the sine of the angle α. Consequently, the instantaneous flux $\phi = \Phi \sin. \alpha$.

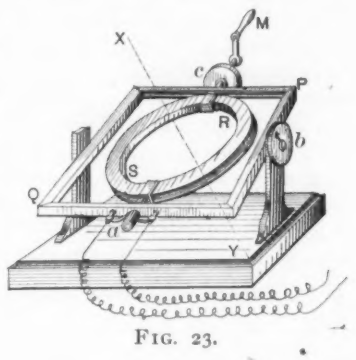


FIG. 23.

37. By following the successive positions of the ring during rotation, in the light of this equation, we find that when A_1 is uppermost, $\alpha = \pi/2$ and $\phi = \Phi$; when A_1 takes position $\alpha = \pi$ and $\phi = O$; when A_1 takes the lowermost position $\alpha = 3\pi/2$ and $\phi = -\Phi$; and when A_1 returns to the position b, $\alpha = 2\pi$ and $\phi = O$.

38. E. M. Fs. will be induced in the ring during this rotation, but their magnitude cannot be assigned unless the speed with which the rotation is conducted be known. The flux will be steadily increasing to the total value Φ, then reduced to zero and again increased negatively to $-\Phi$, or Φ, in the opposite direction, after which it returns to zero. In one revolution, therefore, the linkage changes from $+\Phi$ to $-\Phi$, or the total change is 2Φ, webers. If this change be effected in one second of time, the average E. M. F., or mean E. M. F., during this second will be 2Φ C. G. S. units or $2\Phi/10^8$ volts. If it be effected in two seconds, the mean E. M. F. will be $2\Phi/2 = \Phi$ C. G. S. units, the average E. M. F. in this case being half as great, but being maintained for twice as long a time. If the time of revolution be t_1 seconds, the average E. M. F. will be $\frac{2\Phi}{t}$ C. G. S. units, maintained during a time t. Consequently, the *time integral* of the E. M. F. will be 2Φ webers, and this will represent the integral of the E. M. Fs. induced during rotation, multiplied by the time during which they act, but the successive magnitudes of the E. M. F. cannot be determined until the time-rate-of-change $\frac{d\Phi}{dt}$ is known.

39. If the ring be rotated with an uniform angular velocity of ω radians; *i. e.*, $\frac{\omega}{2\pi}$ revolutions per second, the angle rotated through from the initial position Ob, by the end of any time t seconds, will be ωt radians. Thus, if t, be one second, the angular position reached by the loop will be ω radians from Ob. Consequently, since $\alpha = \omega t$, or $\phi = \Phi \sin \omega t$ webers. The time-rate-of-change of ϕ, or $\frac{d\phi}{dt}$ is therefore known to be $d\phi$, and $\frac{d\phi}{dt} = \omega\Phi \cos \omega t = \omega \Phi \sin (\omega t - \frac{\pi}{2})$, or is known to be a sinusoid of ω times the amplitude of ϕ and lagging 90° behind ϕ in phase.

40. If the loop makes 25 revolutions per second, or 50π radians per second, the flux traversing the loop at any instant will be $\phi = \Phi \sin (50\pi t)$. If the area of the loop be one square metre = 10,000 square centimetres, and the uniform intensity of magnetic flux be one gauss, or one weber-per-square-centimetre, the maximum enclosed flux Φ, will be 10,000 webers, and $\phi = 10{,}000 \sin (50\pi t)$. At $t =$ 1·25 second, this becomes $\Phi = \Phi \sin 2\pi = o$. The flux contained within the loop will, therefore, be a sinusoidal function of the time, and may be plotted as a sinusoidal curve with ordinates of flux to abscissas of time. Such a curve is represented in Fig. 22, by the sinusoid $O\ a\ b\ c\ d\ e\ f\ g\ h$, the period of which is 0.04 second, and the amplitude of which is 10,000 webers, as represented on the left hand scale.

41. If at the initial point O, we lay off a tangent OO', this reaches in 0.01 second an elevation of 15,708 webers, so that if carried on for 100 times this duration or for one complete second, the elevation attained would be 1,570,800 webers. This is the rate at which magnetic flux is entering the loop at the instant O, or the E. M. F. in the loop

expressed in C. G. S. units. If this quantity be plotted on the same sheet to a convenient scale, as the scale on the right hand side, it may be marked off at O, immediately above o. Similarly at the point a, distant in time 0.005 second or 45° from O, the tangent aa', extends in one hundredth of a second to an elevation of 18,180 webers, or 11,110 webers above the position of a. Consequently, in one second, the rate of entering will be 1,111,000 webers per second, and plotted to the right hand scale this is marked off at A, immediately above a, at the elevation as shown. At b, the tangent to the flux curve is horizontal, so that at this instant there is neither increase nor diminution in the flux contained within the loop. In other words, the rate of change is zero. Consequently, the E. M. F. is zero and the corresponding position of B, is marked off on the zero line immediately below b. Continuing in this way with the development of tangents at suitable number of points we establish the E. M. F. curve $OABCDEFGH$. This curve is sinusoidal, or is a cosinusoid with reference to the sinusoidal curve of flux $oabcd$.

42. The above is a geometrical proof of the equation $\frac{d\phi}{dt} = \omega\Phi \cos \omega t$ and shows that the rate-of-change of a sinusoidal function of time, is itself a sinusoidal function, having an amplitude ω times greater than the original function, and having a difference of phase of 90° with reference to the original function. The phase of the rate of change lags behind that of the original function by 90°. Thus, the E. M. F. curve ABC, cuts the zero line in the descending direction 0.01 second, or 90°, later than the flux curve abc, from which it is derived. From similar reasoning it will be found that the time-rate-of-change of a cosine function of the time expressed by $\Phi \cos \omega t$, would be

$$\frac{d\phi}{dt} = -\omega\Phi \sin \omega t = \omega\Phi \cos\left(\omega t + \frac{\pi}{2}\right).$$

Here again the rate-of-change is ω times the amplitude of the original function and is a cosinusoid advanced 90° in phase beyond the original cosinusoid. These are useful relations to remember.

43. Fig. 23, represents an apparatus which forms a simple form of alternator. For all practical purposes such an alternator would be far too weak owing to the fact that the magnetic flux it is operated by is the earth's magnetic flux which is relatively very feeble. This form of alternator, however, is interesting from the fact that it produces a sinusoidal E. M. F. The apparatus consists as shown of a coil of insulated wire wound upon a suitable wooden frame and supported in bearings so as to be capable of being revolved by the handle M. The axis of rotation is supported in a movable frame so as to set the instrument with the plane of the loop at right angles to the direction of the earth's flux at the place where it is rotated. By means of a pair of collector rings with brushes resting upon them, a continuous contact is maintained between the ends of the coil and the external circuit represented by the conducting wires.

If the mean area of each loop or turn on the coil be A, square centimetres, and the number of turns be n, while $\mathfrak{B}$ is the intensity of the earth's magnetic flux in gausses, the maximum magnetic flux linked with the coil will be n times as great as though the coil possessed a single turn, and will be $\Phi = nA\mathfrak{B}$. If $A = 700$ square centimetres, $\mathfrak{B} = 0.6$ gauss, and $n = 5000$ turns, the maximum flux linkage is $= 5000 \times 700 \times 0.6 = 2{,}100{,}000$ webers and $e = \frac{d\phi}{dt} = 2{,}100{,}000 \sin \omega t$, where ω is the angular velocity of rotation in radians per second.

If the coil be rotated say 10 times in a second, or with an angular velocity of 20π, the E. M. F. becomes $e = \frac{d\phi}{dt} = 2{,}100{,}000 \sin (20\pi t)$ C. G. S. units, the amplitude of the E. M. F. e will be $20\pi \times 2{,}100{,}000 = 132{,}000{,}000$ C. G. S. $= 1.32$ volts. The amplitude of the sinusoidal E. M. F. induced in the coil of 5000 turns by the earth's magnetic intensity at the speed of 10 revolutions per second would therefore be about 1⅓ volts. It evidently varies directly with the speed of rotation.

44. A sinusoidal E. M. F. may therefore always be expressed by the equation $e = E \sin \omega t$, C. G. S. units or volts where e, is the instantaneous E. M. F. at any moment t seconds later than the origin selected when the E. M. F. is zero and increasing in the positive direction. E, is the maximum E. M. F. in the cycle or the amplitude of the sinusoid expressed either in C. G. S. units or in volts, while ω, is the angular velocity of the imaginary rotating arm which would be required to trace out the sinusoid by projection. If n, be the frequency of the E. M. F. in cycles per second this arm will make n revolutions per second, and the angular velocity will be $2\pi n$ radius per second; so that $\omega = 2\pi n$.

(*To be continued.*)

Principles of Electrical Distribution.—IX.

BY FRANCIS B. CROCKER.

Five-Wire Systems. (*Continued.*)

THE flow of the currents and values of the potential in five-wire systems may be determined by extending the methods applied to three-wire circuits. Although apparently a complicated matter, a problem of this kind can be solved without much difficulty in most cases. In practice, the current to be supplied is usually known, or its probable value may be assumed. A diagram similar to Fig. 35 should then be made, showing the arrangement of circuits and distribution of current. It is much simpler and ordinarily sufficiently accurate to consider the lamps or other apparatus requiring energy, as located in groups, approximating as closely as possible their actual positions.

This enables the conductors to be divided into sections in each of which the current is uniform, as represented in Fig. 35. The determination of the amount and direction of the currents in the various sections is easily made. If 10 amperes are required at E and also at F, it follows that that amount of current will flow out on the + wire and half way back on the ⊕ wire, there being no current in the rest of this conductor. Since 5 amperes are required at G, one half of the 10 amperes will flow out to that point and the other five amperes will return to the dynamo through the o conductor, the function of the three neutral or intermediate wires being to carry the *difference* between the currents used in the two adjacent portions of the system, whatever its amount and direction may be.

The five amperes required at H are supplied by the Θ conductor, and the 5 amperes used at J by the same current that flows through G, hence there is no current in the outer half of this wire. The cur-

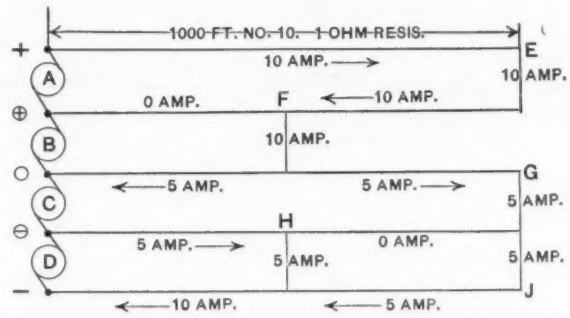


Fig. 35.—Distribution of Current in Five-wire System.

rents from H and J return to the dynamo D by the — conductor as shown. In a similar manner the flow of current in any multiple-wire system may be arrived at, no matter how large or how small the loads on the different parts may be.

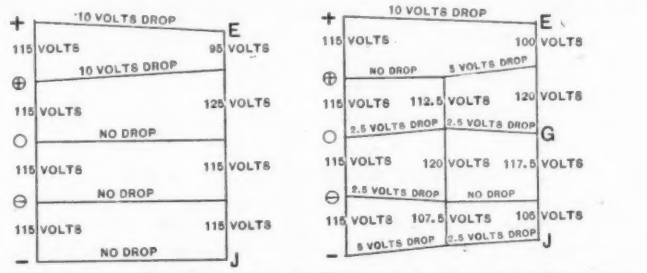
The next step is to determine the voltage at the various points, as indicated in Figs. 36 and 37. Let us first consider the case (Fig. 36.) of 10 amperes being required at E, with no current used in the rest of the system. Assuming each conductor to have one ohm resistance the drop on the + is 10 volts and the same on the ⊕ wire, so that the lamps receive only 95 volts, the pressure at the dynamo being 115 volts. There will be no drop on any of the other three wires since no current is drawn from them. It is interesting to observe that the potential difference between the extremities of the ⊕ and O wires will be 125 volts, as shown. If three other groups of lamps were added so that 10 amperes flow directly across from E to J, the total drop would be 20 volts as before, 10 volts drop being transferred from the ⊕ to the − wire, and each group would receive 110 volts instead of 95, the aggregate number of lamps being four times as great. This brings out forcibly the advantage of a perfectly balanced five-wire system over a two-wire circuit, which the first case practically amounted to.

With groups of lamps placed at E, F, G, H and J (Fig. 37), the pressure is far from uniform, although the system is fairly well balanced in the number of lamps, but not in their position. This potential diagram is made by drawing from the five points marked +, ⊕, O, Θ and — lines representing the pressure in the respective conductors and portions thereof. By comparing Figs. 35 and 37 it will be seen that the direction of these lines is easily and definitely determined, the drop or slope of each section being equal to its resistance multiplied by the current flowing in it. In this connection it should be noted that the current in each group of lamps has been assumed to be constant, but it is evident that the group at E, re-

ceiving only 100 volts, will take less current than those at *G*, where the pressure is 117.5 volts. This fact might be allowed for by modifying the values of the current in proportion to the voltage, but the resistance of the lamps also varies, so that it would very difficult to calculate the current that each group would take. In practice conductors are designed to supply a given current at a certain point, and slight variations in current due to changes in resistance, working conditions, etc., are not usually considered.

This may appear to be a somewhat rough method, but is not only justifiable, but practically unavoidable. In electric railway work, for example, the current required by a car varies greatly with the speed, grade, condition of track, load on the car, etc. Hence the only practicable plan is to assume a certain average current, or a certain maximum current in designing the generating plant, conductors, etc. The average current corresponds to the ordinary working conditions and the maximum current to the greatest possible requirements. The same is true for electric lighting in which variations in the resistance of lamps are far less important than the changes in the number of lamps which are continually being made.

In practice the electric light engineer considers the *initial voltage*



FIGS. 36 AND 37.—DISTRIBUTION IN POTENTIAL OF 5-WIRE SYSTEMS

at the generators, the *drop on the conductors*, which gives him the *voltage at the lamps* and the *current to be supplied* to them. He could easily calculate the resistance of the lamps by dividing the voltage by the current flowing through them, but as a matter of fact he rarely, if ever, does this. It is only the inexperienced student who attempts to apply Ohm's law to the circuit as a whole. The practicing engineer confines it to determining the drop on the wires, which is equal to their resistence multiplied by the current carried by them. The same is true in power transmission and distribution, including electric railway work. In fact it is practically impossible to predetermine the resistance of the whole circuit except in very simple cases.

The writer has never before seen this fact pointed out, although it distinguishes the professional from the amateur without fail.

Seven-Wire Systems.—This is the next higher multiple-wire system that would be used, since it can readily be divided into two four-wire systems, or three three-wire systems, in order to supply current to individual buildings where it is not necessary to carry all seven conductors. Neither the four-wire nor the six-wire systems are capable of being conveniently divided into equal parts in this way, hence they are not to be recommended for adoption, except perhaps in some special case. The seven-wire system, with all conductors of the same size, requires 0.0972, or a little less than one tenth as much copper as an equivalent two-wire circuit, but its complication is so great as to make it of very questionable desirability. Its design and operation would be similar to that of the three- and five-wire systems already described.

(*To be continued.*)

The Application of the Storage Battery to Electric Traction.

As supplementary to Mr. Hewitt's paper read before the Engineers' Club of Philadelphia (not the Franklin Institute, as previously stated) an abstract of which appeared in THE ELECTRICAL WORLD, Feb. 6, the following data giving the cost of operation for the month of October, 1896, will be of interest: First is the cost of operating. From volt and ampere-meter readings taken from the power-house at Beach and Green Streets, 136 576,919 watt-hours were delivered to cable No. 3. By wattmeter records at the battery house 1,728,000 watt-hours were lost in the battery, leaving a difference of 134,848,919 watt-hours delivered to the line at the battery house. These figures do not include the watt-hours generated at the booster, since it has been assumed that this entire amount has been lost in transmission. As a matter of fact, this is not strictly correct; but if a station were operated at Chestnut Hill it would run at a bus-bar pressure a little above the battery pressure, and therefore for present purposes the assumption is correct. Mr. Hewitt stated that from experience in operating power-houses of various capacities it was found that a power-house operated at Chestnut Hill under conditions above described would cost about 1½ cents per kilowatt-hour output. The following is therefore obtained as the cost of generating the number of kilowatt-hours required by the Chestnut Hill branch during the month of October furnished by a station at Chestnut Hill:

134,848,919 kilowatt hours at 1½ cents	$2,022.73
Interest on $85,000 at 5 per cent. per annum	354.17
Depreciation on machinery, etc., at 5 per cent. per annum	354.17
Insurance, taxes, etc	200.00
Total cost of operation for the month by direct method	$2,931.07
Actual cost of operating the battery and boosters:	
Watt hours delivered to cable No. 3, by the bus bar	136,576,919
Watt hours generated by the booster	34.234,648
Total watt-hours delivered to cable No. 3	170,811,567

Mr. Hewitt stated that it is found that the cost of operating the Beach and Green Street power house for the month of October, exclusive of interest and depreciation, was 0.7 cent per kilowatt hour. The following is obtained:

170,811,567 kilowatt hours at 0.7 cent	$1,195.68
Cost of labor and supplies at battery house	179.73
Total	$1,375.41
Depreciation of battery at 5 per cent. per annum	83.33
Interest at 5 per cent. per annum on $33,000	137.50
Taxes, insurance, etc	32.00
Total cost of operation	$1,628.24

Deducting this from the cost of operating by a station at Chestnut Hill, we find the difference in favor of the battery for the month would be $1302.84. At this rate the saving for the year is $15,633.96.

RECAPITULATION.

Saving in cost of installing battery over a new power station for Chestnut Hill	$52,000.00
Saving in operation per annum	$15,633 96

These results speak for themselves, and need no further comment.

These are the specific gravities at the end of full charge:

Maximum specific gravity at 6 p. m	1.201
Minimum specific gravity at 6 p. m	1.184
Average specific gravity at 6 p. m	1.192
Maximum specific gravity at 12 p. m	1.194
Minimum specific gravity at 12 p. m	1.182
Average specific gravity at 12 p. m	1.188

This last specific gravity is practically that preceding the night charge and is an indication of the amount taken out of the battery during the day. At a specific gravity of 1.16 the battery would be about empty; so that at no time was the battery more than over-discharged.

Ground Detectors.

To the Editor of The Electrical World:

SIR:—At the last meeting of the Northwestern Electrical Association Mr. H. C. Wirt, of the General Electric Company, recommended the use of a static instrument as a means of detecting grounds, and stated that such an instrument would be on the market in six weeks. Allow me to call your attention to the fact that such an instrument has been on the market for two years, and that its use is fully covered by United States patent No. 554,275, dated Feb. 11, 1896, granted to me.

JOHN F. KELLY.

PITTSFIELD, MASS.

"Qualitative Mathematics."

To the Editor of The Electrical World:

SIR:—As Prof. Fessenden appears to think that I have intentionally misrepresented him, in regard to one point, I would like to explain that point more fully. The equation (1) on page 528 of THE ELECTRICAL WORLD of May 4, 1895, is as Prof. Fessenden says, obviously a misprint, but the values I took were from the table in the same column just above, which are not misprints, although there are other misprints in the table.

The reason I did this is because it agrees with Prof. Fessenden's written statement. "Since force should be of the same dimensions in all systems of units, we have (dim. of electric force at a point) = (dim. of magnetic force at a point)." In a subsequent communication, Prof. Fessenden says that the second member of this equation should be multiplied by b, and it is because I did not mention this fact in my last communication that the trouble has arisen.

However, I do not see that this correction improves Prof. Fessenden's position, for it reduces his statement to the form: Since force should be of the same dimensions, etc., therefore (dim. of electric force) = $b \times$ (dim. of magnetic force).

Since $a = c$, therefore $a = b\,c$. If I am here doing Prof. Fessenden any injustice, intentional or otherwise, I hope he will make it

clear where the wrong is, but in my present state of mind I believe the fundamental assumption of Prof. Fessenden's article is violated by the introduction of b, and unless that assumption was a misprint also, I do not see how b can belong there.

I did not mean to conceal the fact that Prof. Fessenden said and still maintains that b ought to be there, but I did wish to call attention to the peculiar logic involved. Prof. Fessenden obtains a result which we may call A. I obtain a result B (by guesswork or fraud, if you will, for it is only the result and not the means which is concerned here). Later Prof. Fessenden obtains the result B, identical with mine. Now Prof. Fessenden's results, A and B, are both correct, but my result, B, is incorrect. Black may be white, but it cannot possibly be black. Prof. Fessenden's results are, first, $K = M^{-1} L^{-3} T^{3}$, $\mu = M L$. Second, $K = \mu = T L^{-1}$. Now there is nothing intrinsically contradictory in these two results, providing one admits, what I have held all along, that the dimensions of a quantity are in no sense absolute, but depend on certain arbitrary assumptions. Prof. Fessenden is estopped from taking this position, however, by his own dictum: "There is one, and only one, correct dimensional formula for any given quantity, and that if by any method we arrive at two different formulas, one of them is incorrect." This dictum occurs on page 739 of the issue of June 29, 1895, and so important did its author regard it that he italicized it, no other italics being used in the text of the article. The logic of the 10 fundamental units or three fundamental and eight quasi-fundamental units is very similar.

Next as regards the herring-mackerel story (or red-herring story if you prefer). Although I may be the first to use that particular story for that purpose, I am not the originator of the story, neither am I the first to tell an anecdote to illustrate a mathematical point. I believe that no less a person than De Morgan has done that on more than one occasion, but perhaps I am mistaken. However, Prof. Fessenden is at liberty so far as I am concerned to call me the founder of the "red-herring story" school if that will soothe his feelings. I told the story because I honestly believed and I still so believe, that it forcibly illustrates a logical defect in the school of thought which Prof. Fessenden represents.

The story is funny simply because the sailor's logical error is glaringly apparent to most persons. The error of Prof. Fessenden's school is in my opinion of the same nature, but of course not so obvious, otherwise it would not have required the story to illustrate it.

I have held all along that "the dimensions of the unit of any quantity have nothing to do with its physical nature, or even its physical properties, if such it has, which are independent of those by which the unit is defined in the particular system." Prof. Fessenden took exactly the opposite view, "That the dimensional formula of a quantity is a full and sufficient definition of the nature of that quantity so far as it is possible for human knowledge to go.

I defended my position at some length by sober mathemetical reasoning (not herring stories), but Prof. Fessenden could not be induced to offer anything in defense of his position except the reiterations of his fundamental assumptions, the very points at issue. Perhaps he thought my opinion beneath notice; very well, there is no law against that, but here is the opinion of an authority who cannot be turned down in that way. In Prof. J. J. Thomson's book, "Elements of the Theory of Electricity and Magnetism," page 447, we read, "It may be well to state at the outset that the dimensions of electrical quantities are a matter of definition and depend entirely upon the system of units we adopt," and on the next page, "A theory of dimensions cannot tell us what electricity is; its object is merely to enable us to find the change in the numerical measure of a given charge of electricity, or any other electrical quantity when the units of length, mass and time are changed in any determinate way."

What possible difference can it make in the numerical work whether it is herring or mackerel, and what difference in the dimensions what the ultimate constitution of the ether may be.

We now come to the "practical application" which Prof. Fessenden puts forward as a crucial test of the method and which I am perfectly willing to accept as such.

I will first remark parenthetically that there are unfortunately more misprints in the formulas, but these being corrected, the result follows from the premises really assumed, but not from the experimental data alone. The experimental data are that the period varies according to some function of the length, the mass per unit length and the stretching force. It is not obvious how the student knows he has experimented enough, unless he has an intuitive perception of it, but waiving this point, the data are not only apparently but really insufficient to determine a result, the other necessary conditions being supplied by subsequent assumptions.

It is the assumptions or premises that determine the result and not the particular process used. It is impossible that one process should yield a given result from fewer data than another process. This principle is correctly stated by Prof. Fessenden himself thus: "If in a piece of mathematical work we find anything not implicitly contained in the original assumptions, we know at once that the reasoning is faulty." The second student, because he has found that the frequency is some *unknown* function of the length, mass per unit length and force, proceeds to assume that the form is partly known; that is, the product of some as yet undetermined powers of these quantities, by writing a dimensional equation in that form. If the second student is allowed to add anything in the way of assumptions or conditions outside the experimental ones, it is only fair that the first student be allowed to make the equivalent assumptions in the ordinary algebraic language. The second student having assumed a product function, the first may do the same. The second having assumed dimensional formulas for mass per unit length and force, the first may assume the physical relations from which these dimensions were derived; that is, a force is proportional to the acceleration it produces in a given mass, and mass per unit length is of course directly proportional to total mass and inversely to total length.

The second student makes one more assumption: The dimensional principle that the indices of L and M should cancel out and that that of T should become the same in the right-hand member as in the left. This principle is not evolved from nothingness by introspection (or other process), but is a consequence of the fact that nature is never self contradictory. That is, for example, although we do not know in what manner the stretching force and mass are related to the frequency, we may be sure that it will be such a relation as not to contradict the relations already found from the other experiments and embodied in the dimensional formulas. In other words, the first student has just as much right to make his algebraic equation reduce to an identity as the second student has to make his dimensional equation so reduce. Had the theory of dimensions never been heard of, we might still know that a frequency is inversely proportional to a time, and that "period" (frequency) cannot equal or even be solely proportional to itself, multiplied by some other quantity, unless that other quantity is a constant, which is the same as reducing all exponents to zero except that of frequency itself.

The first student therefore says, force is inversely proportional to the acceleration it is capable of producing in a given mass. That is so far as it is a function of time it is inversely as the second power, or directly as the second power of the frequency. The force being divided by the mass per unit length gives a quantity proportional to the second power of the frequency multiplied by the second power of the length. Extracting the square root of this and dividing by the length, we have a quantity proportional to the frequency.

It may strike some that the assumptions of the first student are not entirely justifiable (which is my own opinion), but they are made in cold blood, under the vulgar glare of the "red-herring" light, and appear in all their nakedness, while the assumptions of the second student, albeit founded on precisely the same natural facts, are partly hidden in the merciful folds of the dimensional notation, but are really open to criticism to the same extent.

The assumption of converses is never quite safe. Because it is absolutely true that the dimensions of both members of a physical equation should be the same; that is, that the dimensional equation should be capable of reduction to an identity, it does not absolutely follow that, the dimensions being the same, the equation is true. This converse proposition is true with certain restrictions. The second student assumed that the frequency could be expressed as a simple product, and such happened by good luck to be the case. Suppose, however, the phenomena under investigation were only expressible as a differential equation, where would he come out? Dimentional formulas take no notice of integrations and differentiations, additions and subtractions; for instance, a line integral of a variable force has the same dimensions as the product of a length by a constant force. The second student blandly assumes that it makes no difference if the tension is not the same throughout the string, but it is not supposed to be proper for the first student to do the same.

The red-herring philosophy is not as pretty as qualitative mathematics, but it does not suffer so great damage by contact with a rude and unsympathetic world.

New York City. Townsend Wolcott.

DIGEST OF CURRENT TECHNICAL ELECTRICAL ARTICLES

COMPILED FROM FOREIGN AND AMERICAN JOURNALS

BY

CARL HERING

DYNAMOS, MOTORS AND TRANSFORMERS.

Modern Type of Dynamo Construction. SCHULZ. *Elek. Anz.*, Jan. 1, 10, 14 and 17.—A series of articles pointing out the characteristic features of the best modern construction of continuous-current and alternating-current dynamos; he limits himself to what appears to be the general opinion in that country as to the best construction; the article seems to be an intelligently prepared summary by a practical constructor.

Arc Lamp Transformer. MORDEY system. Lond. *Elec. Rev.*, Jan. 29.—A very brief illustrated description, in which the point of interest lies in the provision made to prevent any possibility of danger; it is provided with a quick acting switch operated from the outside of the case by a key; the high-tension double-pole fuses are carried on the cover door and are mounted in such a way that the opening of the door disconnects them from the circuit, even if the transformer has not been switched off.

Diphase Alternator. GUILBERT. *L'Ind. Elec.*, Jan. 10.—A well-illustrated description of the Hutin and Le Blanc alternator and transformer together with results of some tests in running them in parallel; the illustrations are the same as those in the article noticed in the *Digest* last week. The Lond. *Elec. Eng.*, Jan. 29, has an abstract of the article with some of the illustrations.

Balancing Armatures. BAXTER. *Amer. Mach.*, Feb. 4.—An illustrated description of a simple apparatus for dynamically balancing armatures. It consists of a frame having two hanger bearings and supported from the ceiling on two long rods with hooks at their ends, leaving the frame to vibrate; the armature with its pulley is placed in these bearings and is made to revolve by means of a current, there being a small magnetic field produced by a pair of magnets supported on the same frame and resembling those of the dynamo, but much smaller; all the parts are readily adjustable for different armatures. When the armature begins to revolve the whole apparatus will vibrate sideways if the armature is out of balance; it can be chalked with the aid of a rigid and stationary support. This method is much better than the use of bars, with which an unbalanced armature will be brought to rest when set to rolling; with the present method the speed may be increased as perfect balance is approached. The same apparatus may be used for balancing any rotating parts by securing an electric motor to the frame and using it for driving the revolving parts.

Care of Electrical Machinery. BAXTER. *Power*, February.—Practical hints concerning the breaking of a wire of the armature.

LIGHTS AND LIGHTING.

Light. ELLIOT. *Elec. Eng.*, Feb. 3.—The beginning of a reprint in abstract of a paper read before the New York Electrical Society. He divides the subject into five different sections; intensity or brilliancy, distribution, diffusion, quality and efficiency, and discusses it under each of these heads. The average brilliancy of illumination varies with the use to which the light is put, but for general purposes the intensity nowhere should be less than one candle-foot, twice this being undoubtedly better; a glaring intensity is a serious error both from the astatic and physiological standpoints. The distribution of light involves two distinct problems, the distribution of the several units and that of the rays from the individual units; the first involves the candle-power of the light and the second the nature of the source itself; the desired result is always to secure a uniform brilliancy; dark parts, even though light enough, appear dark by contrast while light parts are dazzling, for which reason naked lights of any kind are to be avoided. He shows that the theory of lighting is associated with psychology and physiology quite as much as with physics; all rays on either side of the most plainly visible parts of the spectrum are injurious to the eyes; the electric light has an excess of violet rays, while gas flames have an excess of the red or heat rays, both of which are equally injurious; the absorption of these injurious rays by transparent screens is undoubtedly feasible, but seems never to have been suggested.

A distinction should be made between diffusion and distribution, the former referring to the brilliancy at every point of a given space, while the latter refers to the number of rays that cross each point; the eye should be subjected as little as possible to the direct rays; it is a serious mistake in the case of weak eyes to reduce the intensity instead of increasing the diffusion. While much attention is given to increasing the efficiency of a dynamo a few per cent., it is often entirely overlooked that half the light is wasted after it is produced; in the relative economy of gas and electric light the absorption of a third or half of the light by various shades or globes is often overlooked entirely; there has been great neglect and absolute ignorance on the part of those whose business it is to know the principles of lighting; these principles he intends to give and to review the various attempts that have been made to apply them in practice.

Cost of Electric Lighting by Gas Engine. CHRISTY and HASBROUCK. *Elec. Age*, Feb. 6.—A reprint in abstract, including numerous tables and data, of a thesis published in the *Stevens' Indicator*. The figures give the results of an elaborate test of a 10-hp plant; their conclusions are that the production of light in a plant of this kind is more economical than by the direct consumption of the gas in burners; using gas directly the cost of a 16-cp is 0.625 cents per hour; with a gas engine it is 0.29, and with producer gas it is 0.17.

POWER.

Electricity on Farms. *El'ty*, Feb. 3.—An abstract from a recent consular report describing an interesting plant on a farm in Mecklenburg, Germany. Some of the figures are also given briefly in the *Elec. Eng.*, Feb. 3.

TRACTION.

Three-Phase Traction at Lugano. *Elek. Anz.*, Jan. 3.—An illustrated description from an article by Denzler in the *Schweizerischen Bauzeitung*. It includes illustrations of the motor, the truck and the generators; the chief construction data is also given. In conclusion the advantages and disadvantages of this system as compared with the trolley system are discussed. The principal claim against the three-phase motor is said to be its inferiority in the starting effort; this claim was made several years ago, but at the present time the difference as compared with series motors is only a very small one; this is shown by the large number of such moters in use for cranes; on this line it is possible to start a fully loaded car on a grade of 6 per cent. without the use of any special devices which could be used to increase the torque; another objection which has been claimed is the uneconomical method of regulating the speed; this is still of importance when the car must be run for a considerable time at a reduced speed and where economy in power is important; on the other hand there is the advantage for long lines in the self-regulating property for a constant speed with a variable consumption of power, together with the further advantage that the motor acts as an ideal generator on down grades; the more simple construction and the greater output per weight are further advantages; among the disadvantages are the difficulties in the line construction in a city, if there are many crosses on switches, owing to the double overhead wires; the liability of trouble due to the short circuits is also increased; there is less danger of injury from the overhead lines, and the liability of trouble from lightning is not greater; the trouble due to electrolysis is relatively small. One of the chief troubles was the effect on telephones; in the present case a metallic circuit was found to be absolutely necessary for the telephone lines. In conclusion it is thought that considering everything the multiphase current system for traction has shown itself to be practical especially for long lines on account of the reduced cost of the circuits. A brief abstract of the article with a map of the line is given in the Lond. *Elec.*, Jan. 29.

Electric Vehicles. KRIEGER system. *L'Energie Elec.*, Jan. 16.—An illustrated description of the carriage. It is made of an old carriage which has been in use for a number of years in Paris; there is a motor on each of the front wheels; the total weight is 1150 kg, and it can run 30 km; the Fulmen accumulator weighs 285 kg; illustrations are given. Another form weighs 1880 kg empty, but can run 80 km at one charge; the battery has a capacity of 450 ampere-hours, the total weight being 640; there are 16 cells; the two motors weigh 150 kg and generate a maximum torque of 13 kgm; it has already run 2509 km in Paris. Another form is to be constructed to run 125 km and carry two people; it will weigh 800 kg, of which 350 is for the accumulators, the type of which is not given.

Mechanical Traction in Paris. *Bul. Soc. Int. des Elec.*, December.—A very long report of a discussion consisting chiefly of a report by Hillairet on the various methods of traction in Paris; it seems to be chiefly of local interest and does not contain any tabulated data; an abstract of it is given in *L'Energie Elec.*, Jan. 16.

Liverpool Overhead Railway. COTTRELL. Lond. *Elec. Rev.*, Jan. 29.—An illustrated description, apparently taken from a British Association paper, of the recent extension of this line.

Heilmann Locomotive.—The first one of the improved locomotives was taken out on a preliminary run in France on Jan. 21; no reports as to its operation have been published.

Application of the Storage Battery to Electric Traction. Hewitt. *Proc. Eng. Club of Phila.* January.—A reprint of a long paper in which he discusses the application of the battery on the car, its use as a stationary battery for long lines, and in the power house itself. In the first portion he describes at some length tests which he made four years ago with an odd form of battery which has not come into use; the tests appear to have been carefully and thoroughly made and the results are given in some detail, and are rather unfavorable to this use of the battery. In the second portion he describes the installation of a stationary battery at the end of a long line in Philadelphia, including illustrations of the voltage records with and without battery; this portion of the paper was fully abstracted in The Electrical World last week. The use of the battery in power houses is passed over with a mere notice, as there is a great lack of data on this method. In his conclusions he expresses the belief that there is a wide and growing field for the battery as a potential regulator on long lines and for a road regulator in power stations, but he does not think there will be any marked success in its application to moving vehicles. In the discussion Mr. Scott gave some figures regarding the working of the abandoned accumulator line in Washington.

Motor Vehicles. Elec. Jour., Feb. 1.—A few illustrations of different types of cabs and of an omnibus.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Capital, Outlay, Receipts and Expenditures of Central Stations in London and the Provinces. Lond. *Elec.*, Jan. 29.—A large table published in the form of a supplement, giving this information for the statutory stations. No totals are given, but the results are discussed in a long editorial. The table includes 10 London companies, 2 vestrys, 18 provincial companies and 30 provincial local authorities; it is limited to those having an annual output of at least 50,000 units, and having been worked for at least a year; the 11 companies and three vestrys now at work in the metropolis have expended 4.5 million pounds sterling; omitting the municipal stations there remains six which paid dividends at once, and which represent nearly the best that can be done in that country; these have the low capital expenditure per kilowatt hour sold, of $1.12, the ratio of expenses to receipts averages 60 per cent., and the coal bill per unit sold averages a little less than 1.5 cents. The capital expenditure of the provincial companies averages a little over $1.36 per unit sold in spite of one in which this is very high; the coal bill per unit sold is a little over 2 cents; the average capital expenditure of municipal ventures is somewhat larger and the outlay and the coal bill per unit are sold decided lower than in the case of the companies; the average capital expenditure is 59,000 pounds sterling as compared with 52,000 for the companies; the other two figures are $1.12 and 1.5 cents; the superior financial economy of municipal enterprise is therefore proved by these figures.

Chester. Lond. *Elec. Rev.*, Jan. 29.—A brief description of this central station, in which a three-wire system with 420 volts across the outer wires is used in connection with accumulators; the greatest distance to the consumer's terminals is 1900 yards and it is the intention to go considerably beyond this.

Municipal Insurance. Pearson. Lond. *Elec. Eng.* and Lond. *Elec. Rev.*, Jan. 29.—A reprint of a recent paper read before the Municipal Electrical Association; the former journal also contains a part of the discussion; an abstract of the paper is published in the *Lond. Elec.*, Jan. 29.

British Guiana. Vyle. Lond. *Elec.*, Jan. 29.—A short article on electric lighting in that country.

Electricity at the Chicago Cycle Show. Kimbark. *West. Elec.*, Feb. 6.—An article describing this temporary plant, which is said to include the largest number of incandescent lights ever provided for in a similar space of time and at one place, the entire work being done within three weeks; much of the current was obtained from central stations. There is also an illustrated article on this show; the plant included 25,000 lamps.

Hospital Plant. Elec. Eng., Feb. 3.—A short article on the plant at the Pennsylvania State Hospital for the Insane, at Norristown, including some curves, showing the output and cost of operation.

Paterson. Power, February.—An illustrated description of this new Edison station.

WIRES, WIRING AND CONDUITS.

Aluminum Conductors. Burr. *Elec. Eng.*, Feb. 3.—A brief description of the conductors used by the Pittsburg Reduction Company, for which aluminum was preferred to copper; the weight of copper which would have been required is 24 tons, while with aluminum it is only 11.5 tons; for the same weight, aluminum has a conductivity relative to copper as 208 is to 200; the temperature coefficient is nearly the same; each of the long vertical conductors is made up of 250 rods 350 feet long and 3/8 inch in diameter. He thinks it has passed the experimental stage and that aluminum has shown itself as an electrical conductor to be equal to copper. (Nothing is said about its price nor about the difficulties in making soldered connections at the terminals.)

ELECTRO-PHYSICS AND MAGNETISM.

Electric Discharges and Their Conversion into Röngten Rays. Puluj. *Zeit. f. Elek.*, Jan. 1; an abstract of a recent lecture in which he showed the connection between optical and electrical radiation.—Among other things he stated that the Hertzien rays or electrical oscillations generated by the discharge of Leyden jars, had a frequency of 100,000 to 1,000,000 per second according to the size of the jar; in order that these rays should become visible as red light, the frequency would have to be increased to 400,000,000; a tuning fork making 1000 vibrations per second would have to vibrate 1200 years to make this number of oscillations; the pulsations of electric rays become more rapid the smaller the metallic coating of the Leyden jar, and calculations show that if this coating is as small as material molecules the oscillations would reach many billions in frequency: if therefore the molecule discharges its electricity to another, oscillations would be produced which might under certain circumstances be perceived as light; if the frequency is greater than 700,000,000,000, ultra-violet rays would be produced, and at still higher frequencies a radiation would be produced which would have to be different from the ultra-violet radiation. In the discussion of discharges in high vacua he endeavored to explain the various light, heat and magnetic phenomena by the assumption that small particles of gas and metal which are charged statically at the negative electrode, are torn off and projected with great velocity; they discharge their electricity on the walls of the tube or other bodies, thus producing electric oscillation in the ether which becomes visible as phosphorescent light; other oscillations are also produced which are considerably more rapid, and these are, in his opinion, the Röntgen rays. One of the interesting features of his lecture was an exhibition of his so-called phosphorescent lamp, which he constructed 15 years ago and described at that time; it generates not only very intense Röntgen rays, but also transforms nearly all the energy of the current into light; it consists merely of a piece of mica painted with sulphide of calcium subjected to the action of cathode rays, but it generates an intense greenish white light; according to measurements of Ebert one horse-power would be sufficient for operating 46,000,000 of these lamps of 16 candle-power; owing to the difficulty of making these measurements the results may not be very accurate, but they show the possibility of considerable progress in lighting. According to Prof. Lodge if mechanical energy could be converted entirely into light alone a single man turning a crank of a suitable machine could generate enough light for a whole city. Puluj believes the solution of this question will, perhaps, be more in the domain of chemistry than in that of electricity.

Recent Contributions to X-Ray Literature. Lond. *Elec.*, Jan. 29.—A short summary of a few of the articles published during the past seven months.

Ether and Light. Friedrich. *Elek. Anz.*, Jan. 17.—An article of a theoretical nature on various rays in ether; he makes a somewhat peculiar classification; the article does not appear to be of special interest.

Zig-zag Forms of Long Sparks. Monckman. Lond. *Elec.*, Jan. 29.—An abstract of a paper read at the Cambridge Philosophical Society. He thought that the irregular form of the path was due to particles, not necessarily irregularly distributed, but charged by induction or convection, attracting the spark away from the straight line; he describes some experiments, from which he concludes that with short sparks the irregular course is probably produced by charged particles, but with longer flashes, as in lightning, his experiments indicate the cause; the rain-drops do not form a conducting path, but being charged by induction attract the current, a small portion of it being thrown off to these bodies; this action is of importance, as every side flash decreases the quantity of the main flash, so that in the case of lightning with many angles only a small portion of electricity will arrive at the end of the course.

Passage of Electricity Through Gases. Baly. Lond. *Elec.*, Jan. 29.—A brief abstract with a discussion of a Physical Society paper of a purely controversial nature; he argues that the electrical conduction in gases is not of an electrolytic nature, his arguments being the following: "That the sign of the charge on the supposed gaseous ion is variable; the initial resistance of a gas; the invalidity of Ohm's law; the permanence of the supposed gaseous electrolyte; that every mixture of gases must equally be an electrolyte; that the potential gradient in a vacuum-tube when the current is passing has been shown to be very uneven; it is very steep in the cathode glow, and is by no means a regular decline between the electrodes."

Selenium. Majorana. *Proc. Lond. Phys. Soc.*, December; abstracted briefly from the *Nuovo Cimento*, page 30.—He shows that selenium changes in resistance only gradually when light strikes it; with a revolving disc, intermittent illumination caused a constant resistance.

Electric Spark in the Magnetic Field. Mastricchi. *Proc. Lond. Phys. Soc.*, December; abstracted briefly from the *Rend. Acc. Linc.*, page 171.—In a strong magnetic field there is an apparent increase of the resistance in the circuit comprising a spark with induced current; the duration of the discharge is lessened by strengthening the field; the potential re-

mains the same; the quantity at each discharge is less and the residual charge after each spark is greater; the time necessary for recharge is therefore shortened; there is no true increase of specific resistance of the medium traversed by the spark; the apparent increase is due to the alteration in the form of the spark.

Magnetic Hardness. BECK. *Proc. Lond. Phys. Soc.*, December; abstracted from the *Wied. Ann.*, 59, p. 84.—A criticism of Kohn's recent paper on the same subject; both measured the screening effect, Beck obtaining negative results and Kohn positive.

Stresses and Magnetization. MEYER. *Wied. Ann.*, 59, page 134; abstracted in the *Proc. Lond. Phys. Soc.*, December.—He investigated the manner in which tensile stresses affect the magnetization and thermo-electric properties of wires.

Magnetic Amalgams. NAGAOKA. *Proc. Lond. Phys. Soc.*, December.—A brief abstract of his recent paper from the *Wied. Ann.*, 59, page 66.

X-Ray Apparatus. WILLYOUNG and SAYEN. *Elec. Eng.* and *Elec Rev.*, Feb. 3; a continuation of the reprint of a recent paper noticed in the *Digest* last week.—They discuss the relative advantages of the induction coil and the Tesla coil, favoring the former; they have never seen results obtained with the Tesla coil which are equal to those obtained with the induction coil. They favor the focus tube; everything depends upon the vacuum, the penetrating power being greater the higher the vacuum, hence different tubes should be selected for different uses; the chief difficulty is the change of vacuum which takes place while in use, which is thought to be due to the occlusion of the residual gas on the inner surface of the glass; when a platinum reflector is used with an anti-cathode, and the anode is aluminum, a simple reversal of the discharge will prove fairly successful; heating a chemical in the tube involves the difficulty of heating it to a slight amount; the change of vacuum is so rapid that it gives trouble after a few moments' exposure; eventually there will be almost complete exhaustion and the tube must then be returned to the makers. They favor the Bowdoin tube, in which the reflector is not connected to the coil at all, which entirely prevents blackening, and the inner surface of the tube is covered with a fluorescent material fused into the glass, this material giving off just enough air or vapor to make up for the occlusion due to the working of the tube and the vacuum therefore always remains constant, the tube requiring no nursing whatsoever; it should always be used with a parallel spark gap of 1 or 1.5 inches; it may be used for one or two hours without the slightest attention. The life of a tube is limited by the vacuum becoming too great and by the ability to stand electrical strains; six or eight hours continuous working incapacitates the average tube, but the life of the Bowdoin is 10 or 15 times as great; all well-made tubes are equally liable to the limitation due to the electrical strains which appear to be accumulative in their effects, the tube eventually breaking down. General instructions are given for exposure, manipulation, development, adjustment, etc., based on their experience.

X-Rays or Static Discharge. FREI. *Elec. Eng.*, Feb. 3.—A continuation of the discussion as to the non-injurious effect of X-rays on the skin when a static machine is used. The machine was powerful enough to show the palpitations of the heart, and its power was therefore by no means small; the anode was grounded; in another experiment in which it was not grounded injurious effects were produced, which obliged him to modify his former views; he claims that the injury was caused by an electric discharge from the wires; he is not prepared to say whether the device of grounding the anode would have the same protective effect when an induction coil is used.

Gun Magnet. KING. *Elec. Rev.*, Feb. 3.—A communication giving in detail the results of some measurements made in June, 1895, with large magnets made by wrapping 10 miles of wire around a 15 inch cast iron cannon; the field was measured by compass needles placed at various distances; no conclusions of importance are drawn.

ELECTRO-CHEMISTRY AND BATTERIES.

Electro-Chemical Lecture Apparatus. NERNST. *Zeit. f. Elektrochemie*, Jan. 20.—A brief illustrated description of two pieces of apparatus which he uses in his lectures. One of these shows the migration of ions; it is a U-tube, the lower part of which is filled with a dilute solution of permanganate of potash, above which the tube is nearly filled with a dilute nitric acid; the permanganate solution should be made of the same conductivity as the nitric acid, by the addition of a little urea, its specific gravity being made slightly greater; there should be a sharp division line between the two liquors and for that reason the permanganate solution is introduced through a capillary tube from the bottom; the electrodes enter the nitric acid; by applying 70 volts, the surface of separation will move in the opposite direction to the current at the rate of 1.5 mm per minute; but commutating the current, it will move in the opposite direction; by measuring the movement for a known voltage, the velocity of the ions is obtained in absolute units; one can determine with it whether a colored substance, as anode or cathode, migrates or not. The second apparatus is to show that mercury cathodes at a high current density will form amalgams in alkaline solutions; the cathode is a fine stream of mercury issuing through the liquid from a funnel and falling into the bottom of the tube, where it is separated from the liquid by a layer of chloroform or other suitable non-conductive, inactive liquid; the anode is a platinum spiril around the mercury thread.

Carbon Electrode for Electrolysis. LESSING. *Elektrochem. Zeit.*, January.—A short article calling attention to the importance of a suitable carbon electrode for industrial electrolysis, and claiming that the destruction is not only chemical but more particularly mechanical, through the evolution of gas and heat in the pores; moreover the particles of carbon are cemented together instead of the plate being a homogeneous block. He then states that after several years of experimenting he has now succeeded in producing a carbon material which is almost as though it had been made of melted carbon; it is homogeneous throughout, contains absolutely nothing but pure carbon, is a good conductor, has great mechanical strength, the appearance of steel, has a metallic ring, and is so hard that it cannot be ground with an emery wheel and scratches glass with ease; extended trials have shown that its life is very great; no further description is given; he states that he is prepared to make such plates.

Electricity in Chemical and Metallurgical Industries. KERSHAW. Lond. *Elec.*, Jan. 29.—The continuation of his serial; he discusses briefly the subject of aluminum and gives a table showing the production in the principal countries from 1885 to 1895; it is greatest by far in Switzerland, where it is almost twice as great as in the United States, which comes next; in both of these the increase has been very rapid: in France it is much less and has diminished in the last year, while in England it has fallen down to nothing; a list of the aluminum works and details of the runs are given.

Separating Metals by Means of Soluble Anode. PAULI. *Elektrochem. Zeit.*, January.—A brief description of an application of this method; a certain mineral was analyzed in which the antimony was separated out by making the mineral a part of a cell which was then short circuited.

Diaphragm. Elek. Anz., Jan. 21.—A statement that Hoepfner has recently devised diaphragms made of plates of mica, perforated with innumerable small holes; they have the advantage of being very thin and strong, besides having a low internal resistance; he suggested that they might be used to advantage in accumulators, provided they do not come in contact with the electrodes, particularly the anode.

Alkalines and Bleach. KELLNER. *Zeit. f. Elek.*, Jan. 15.—The first part of an abstract of some Austrian patents with some illustrations of this apparatus; it is claimed that this is a solution of this important problem.

Electro-Chemical Apparatus and Processes. Zeit f. Elektrochemie.—This journal, which appears twice a month, contains many abstracts, often accompanied by illustrations, of German, English and American patents on this subject; the descriptions are often quite complete; they will hereafter not be noticed individually in these columns. The *Elektrochem. Zeit.*, a monthly, contains very brief abstracts with occasional illustrations of German patents on this subject.

Purification of Sugar. Zeit. f. Elektrochemie, Jan. 20.—An abstract of some length, including experimental data, from a report by Baudry on the Schollmeyer and Huber process, which is used industrially in Stepanowka and Woronowitza, in Russia.

Influence of the Solvent of the E. M. F. of Cells. KASANKINE. *Proc. Lond. Phys. Soc.*, December; a brief abstract from the journal of the Russian Physical and Chemical Society.—Both electrodes were of the same metal, namely, that contained in the electrolytic salt; the solvents were water and amyl alcohol; the results, which are not given in the abstract, it is stated, are not explained by the theory of Nernst.

Mechanical Theory of Electricity and Chemical Action. HAYCRAFT. Lond. *Elec. Rev.*, Jan. 29.—A further criticism of Whitwell's theories.

Electro Chemical Theory. BUCHERER. *Elektrochem. Zeit.*, Jan. 2.—Communications in reply to criticisms of his theory, more particularly to the recent attack of Danneel.

Electrolysis of Gold. Zeit. f. Elektrochemie, Jan. 20.—A description of some length of a recent process patented in Germany, which is said to contain some methods for the separation of gold from the platinum metals by electrolysis.

Electrochemistry in 1896. WEYER. *Elektrochem. Zeit.*, January.—The first part of a summary of progress during the past year.

Carborundum. FITZGERALD. *Jour. Frank. Inst.*, February.—A reprint of a recent lecture on the manufacture and development of this material at Niagara Falls; illustrations of the furnaces and other apparatus for its manufacture are given. It appears that it takes seven hp-hours to produce one pound of carborundum.

Cyanide Process. RICHARDS. *Jour. Frank. Inst.*, February.—A reprint of a recent lecture discussing the patented basis of the MacArthur-Forrest process and giving a detailed description of it.

UNITS, MEASUREMENTS AND INSTRUMENTS.

B. A. Unit. LINDECK. *Proc. Lond. Phys. Soc.*, December; a notice of an article from the *Zeit. Instrumentenkunde*, 16, p. 272.—He compared certain B. A. ohms of recognized importance with the mercury standards of the Reichsanstalt; he found that one legal ohm was equal to 1.01063

B. A. units; one international ohm to 1.01349 B. A. units; and one Siemens unit to 0.95342; it is usual in England to take one legal ohm as equal to 1.01072 B. A. units, which makes a difference between the English and German ohms of 0.01 per cent., by which amount the former is greater than the latter.

Photometry. Violle. *Bul. Soc. Int. des Elec.*, December.—A short paper in which he defends his platinum standard of light, and describes briefly how it is used; he claims that the difficulties lie in the materials rather than in the use of the apparatus; if the secondary standard is sufficiently constant the comparisons will give remarkably concordant results; he has obtained three or four times the usual precision, namely, one sixtieth, which has been considered to be the indisputable limit of accuracy of photometric measurements; he has constructed a practical model of the apparatus.

Testing Set. Lond. *Elec.*, Jan. 29.—An illustrated description of a portable testing set made by Nalder Bros.; one of these is specially designed for testing cables and circuits on the streets.

Alternating Current Meter. Hummel. *Elek. Anz.*, Jan. 17.—An illustrated description with diagrams, of the new form of this meter.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Rapid Cable. Lond. *Elec. Rev.*, Jan. 29.—A brief comment and criticism of the cable recently proposed by Prof. S. P. Thompson, as described in a daily paper. The cable has two separate conductors, each perfectly insulated and inclosed within the same armor; at intervals of every 100 or 150 miles he introduced stretches of cable with three separate conductors, the third being a wire or high resistance acting simply as a leak, one end being connected to the positive and the other to the negative conductor; by introducing a sufficient number of such leaks the retardation can be entirely gotten rid of. This appears very similar to the one described in his patent of 1891. In the criticism, which is not favorable, attention is called to the fact that the more effectual the leaks, the higher must be the voltage of the signalling battery to make up for the loss, and the more likely therefore it would be to develop a weak point; attention is called to the difficulties encountered in the repairs of such a cable, although the inventor claims that experienced manufacturers admit that the change will be perfectly simple and would not involve any new difficulties; it is thought that there would be considerable difficulty in locating the position of the fault in such a complex system. Thompson claims that the obstacle to the Pacific cable has been the 3600 mile stretch, and it is thought that 12 words a minute is the utmost that could be hoped for from a single wire; the maximum speed on the Atlantic cable, he states, is 32 words a minute; the criticism states that the usual speed is 25 for the lighter ones and 50 is practicable with the heavier core cables; Thompson claims that the more perfect the insulation the greater is the capacity and retardation, while the criticism states that the reverse is the case.

Induction in Multiple Core Cables. Dresing. Lond. *Elec. Rev.*, Jan. 29.—A communication stating that brass tape with a metallic sheeting around each core of a submarine cable, as a remedy against induction, was first proposed by Gulstad and himself in 1891. In a recent paper Preece stated that there is still some disturbance observable in such a cable, and that the induction will probably disappear entirely if the electromagnetic effect were removed also; the present writer suggests that the remaining inductive effect can be eliminated by inserting condensers and variable resistances between the cores as described by him in 1891; momentary currents can thus be sent through the receiving instrument opposite to the inductive impulses from the cores, thus balancing the one against the other; it is used on cables in Chinese and European waters; a diagram shows the connections when the four cores have to be screened mutually.

Printing Telegraphy. Hoffman System. *Zeit. f. Elek.*, Jan. 15.—An illustrated description of an apparatus which is spoken of very favorably; in external appearance it resembles a typewriter; it differs from most others in not requiring any synchronous motions at the two ends; there is a step-by-step motion and the construction is said to be remarkably simple.

Block Signaling. Boult. Lond. *Elec. Rev.*, Jan. 29.—A continuation of the discussion of his system.

Telephone Commutator. Biegler. *Zeit. f. Elek.*, Jan. 1.—An illustrated description of the one used in the plant at Bruenn.

MISCELLANEOUS.

Conventional Diagrams. Tanner. *Elec. Eng.*, Feb. 3.—An abstract of a recent paper read before the Chicago Electrical Association, including a large number of conventional diagrams for electrical apparatus which have been selected as those best adapted for the purpose. (They are not always of the simplest kind nor are they the most convenient to reproduce in hand drawings; furthermore some of them differ from those in general use.)

Lewis Institute. Carman. *Elec. Eng.*, Feb. 3.—A brief illustrated description of this educational institute, which was recently opened in Chicago; there is no separate apartment for electricity, as it was thought that this study could be carried on as fully in connection with physics as in any other way.

New Books.

The Commercial Organization of Factories. By J. Slater Lewis. E. & F. N. Spon, London; Spon & Chamberlain, New York. Cloth, large octavo, 540 pages. Price, $12.

One of the most difficult problems with which managers of large industrial establishments have to contend is that of devising a satisfactory commercial organization. It is obviously of vital importance that the function of each of the various departments of such institutions shall be clearly defined, that these departments shall work harmoniously together, and that accurate records shall be kept of all transactions which take place in and between them. Any system which fails to accomplish these results in an orderly and business-like manner must be regarded as unsuccesstul, and, unless the weak points be found and remedied, will usually result in a more or less chaotic condition of affairs.

In general it may be said that no system of factory organization and accounts can be found which in its entirety is equally suitable for two different manufacturing plants, hence it is necessary for each manager who has not been so fortunate as to have had a thoroughly systematic and capable predecessor to work out and apply his own solution, or at least to make extensive modifications to some previously known system in order to adapt it to his purpose.

Mr. Lewis' book is a comprehensive treatise upon the management of factories, including the duties and responsibilities of the various officers and other employees, the relations of the different departments to one another, the numerous and frequently complicated transactions between the departments and methods of keeping accurate records of these transactions.

The author describes and explains in detail various books and forms required for keeping accounts; sample forms are printed throughout the work. A pocket in the back cover contains diagrammatic representations of the system of accounts advocated, and the body of the work also contains numerous diagrams and curves, many of which relate to the cost of manufacture, selling prices, etc.

As the book is written entirely from an English standpoint many of the forms would have to be somewhat modified to conform to American practice. The system of accounts developed by Mr. Lewis is very extensive, and the complete scheme could only be employed to advantage in the larger manufacturing establishments, as many of the departments treated separately are usually combined in smaller companies. A feature of the book, which deserves special mention, is the very excellent and complete index, consisting of 30 pages.

Mr. Lewis may be congratulated on having produced a work which cannot fail to be of value to any one interested in factory management and accounts.

The Tutorial Chemistry; Part I., Non-Metals. By G. H. Bailey, D. Sc. and edited by William Briggs, M. A., F. C. C., F. R. A. S. (In the University Tutorial Series.) W. B. Clive, London; Hinds & Noble, New York. Cloth, 12mo, 232 pages, 39 illustrations. Price, $1

This little book is intended for use as a text book for fairly advanced students and as a laboratory companion.

The treatment of such a subject as the chemistry of the non-metals in so small a volume is necessarily incomplete and has generally resulted in the production of works of little value. This appears to be an exception, since the treatment is thoroughly scientific and moreover highly practical.

The authors have paid particular attention to the subject of chemical calculation and to the details of certain industrial chemical operations, such as the manufacture of sulphuric acid. The book is sufficiently modern to contain references to argon and helium but no reference is made to the new calcium carbide process for the manufacture of acetylene and for some reason the important cyanogen compounds are not mentioned.

The subject of chemical physics and the consideration of the Mendeljeff series are reserved for the second part of the work.

The book, though unfortunately limited by the insularity of opinion which generally pervades English text-books, is a good one, and in the hands of a competent instructor will prove a valuable assistant in the laboratory.

The Tutorial Statics. By William Briggs, M. A., F. R. A. S., etc., and G. H. Bryan, Sc. D., F. R. S. W. B. Clive, London; Hinds & Noble, New York. Cloth, 12 mo; 276 pages, 189 diagrams. Price, $1.

This work is an attempt to treat statics from a rather elementary standpoint and at the same time to cover the ground very thoroughly. The result is a rather diffuse treatise which could be advantageously revised for students somewhat more advanced in mathematics. It is difficult to treat the more involved statical problems with very elementary mathematics, and the use of plain geometry methods is apt to lead to confusion. Whether it would not be better to postpone a student's introduction to this subject until his mathematics is more mature is a question for the instructor's judgment.

The book has, however, a feature which will be very useful to any teacher in the very large number of examples and problems it contains.

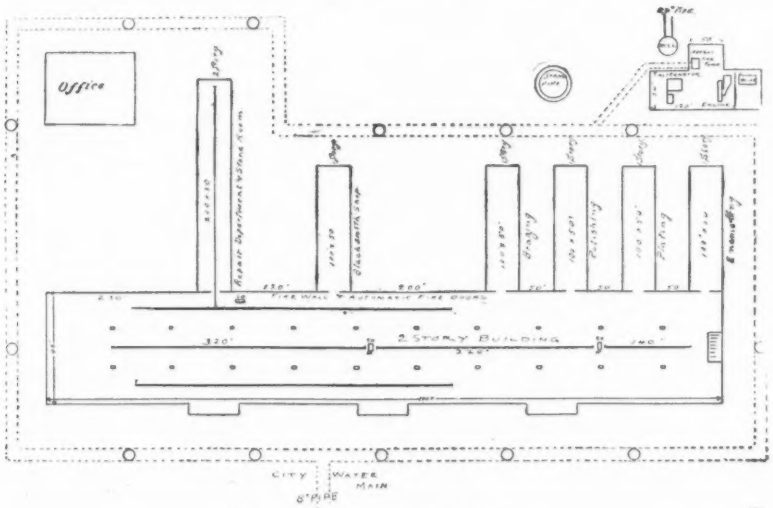
Three-Phase Power Plant in a Bicycle Factory.

An installation interesting to bicycle manufacturers in particular, and to all other manufacturers in general, is now under way at Middletown, Conn., where the Keating Wheel Company has just completed a factory unique in its construction and in the application of its motive power.

The unique feature of this factory lies in the fact that it will be entirely operated by electricity, not an engine or a main belt coming into the factory proper. The system chosen is the three-phase system of the General Electric Company.

The engine and generating plant is located in the southeast corner of the plot, in a two-story brick and stone building. Steam is generated by a Babcock & Wilcox boiler of 250 horse-power, separated by a brick partition from the engine room. The engine, a cross-compound condensing Greene engine of 500 horse-power, the high pressure side only of which is installed, is erected upon the second floor upon brick and stone cap piers built up from the ground. On the same floor is a General Electric three-phase generator, known as an A-T 16-pole, 250-kw, 450-revolution, 60-cycle machine, also placed on piers carried up from the ground. The main belt from the engine and fly-wheel passes down to the ground floor, where a countershaft runs in bearings set upon brick and stone piers. The shaft is carried the entire length of the room and from it will be driven eventually another three-phase machine probably of similar capacity, as well as a set of lighting machines, to be erected at Middletown as soon as they can be removed from the present factory of the Keating Wheel Company, at Holyoke, Mass. This countershaft is arranged with couplings, so that any portion may be cut in or out, as may be required.

The exciter for the generator is a 4½-kw machine of the I. B. type, run from a pulley on the shaft of the three-phase machine. Facing the generator is a Vermont marble switchboard carrying packed Card rheostats, current indicator, voltmeter and the necessary switches for controlling the exciter and the generator. From the switchboard six wires, forming two circuits, issue from one of the windows of the power house and pass to the main factory, supported on one pole only. They are carried above one of the windows on the second floor of the factory, and



PLAN OF BICYCLE FACTORY.

there three of the wires terminate, while the other three, which constitute the circuit in service, follow the centre of the roof of the second story for about three-fourths of the length of the whole building. At the proper place they are tapped off, descending their respective pillars and passing through the floor of the second story to the motors suspended from the ceiling of the first story.

The main building, 1000 feet long, is one great hall supported on rows of pine pillars set 10 feet apart. It will be seen by the diagram of the building that the main shafting is about 800 feet long and runs down the central aisle, being divided into three sections between each of which is a 50-hp General Electric induction motor of the inverted type. There are other shorter lines of shafting which are about 350 feet long, one on each side of the main shafting in the north part of the building. Still another line of shafting about 200 feet long runs through the repair department. The motors driving the shafting in the main building are two 50 horse-power, while the line of shafting running through the repair shop is driven by a 20-hp motor, secured to the ceiling of the first floor in the main building.

The entire factory has been laid out by Mr. R. M. Keating himself with all the care which a man can bestow upon a child of his own creation. It is protected from fire by a system of sprinklers located in the building. Furthermore, a water pipe shown in the diagram, surrounds the entire factory, and is connected with an eight-inch city water main on one side of the building and with a 1000-gallon fire pump on the other.

The Keating factory, when in running order, will be one of the most complete and modern cycle factories in the world, and is the outcome of two years' close study.

New Wiring of the New York Stock Exchange.

Those who are familiar with general interior electrical construction will readily appreciate the many difficulties involved in replacing the old wiring in a large occupied business building with an entirely new distributing system, without in any way affecting the continuous service throughout the building. Such work must generally be carried on with the minimum disturbance and annoyance to those who are housed within the structure and is frequently hampered by other restrictions, particularly if the new installation is to be entirely concealed conduit work.

This may well be said of the work recently completed in the New York Stock Exchange by the New York Electric Equipment Company, Thirty-third Street and First Avenue, New York City.

All wires throughout this building feeding some 822 lights from 286 outlets and the necessary circuits for four motors were entirely discarded, and an entirely new iron-armored conduit system was substituted. All the fixtures were also rewired. Rubber-insulated wires were used throughout, run in either Bergman steel or iron-armored tubes.

The main hall is lighted by four 75-light electroliers and numerous side lights on the ground floor and galleries. The remaining lights are located throughout the various offices located on the five floors of the Broad Street front and Wall Street wing of the main building. Current

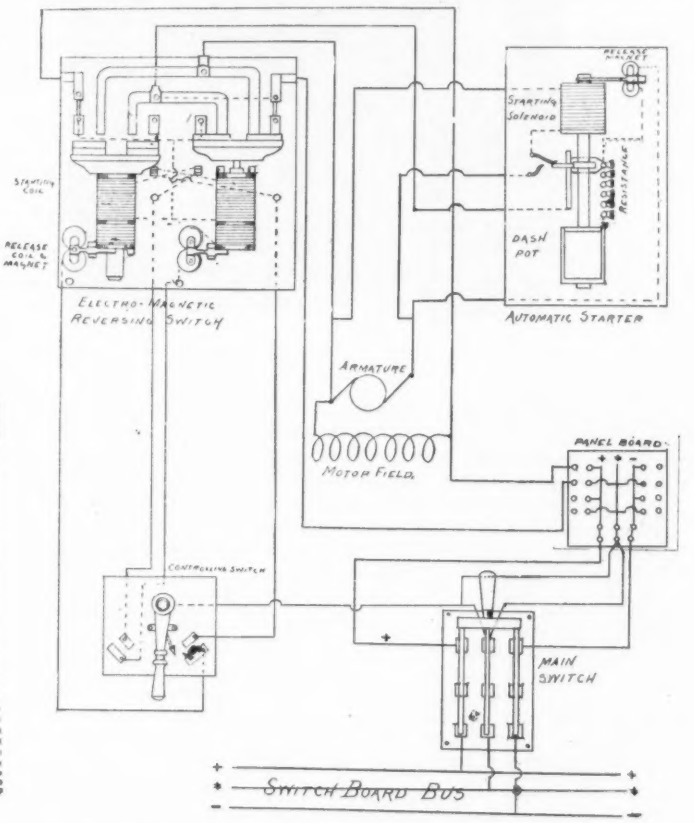


FIG. 1.—DIAGRAM OF MOTOR CONTROLLING CIRCUITS IN THE STOCK EXCHANGE.

has always been supplied from the street service of the Edison Electric Illuminating Company. No particular change was made in this direction, excepting the general improvement of the service connections. A double three-wire service enters the basement of the Wall Street wing, and terminates at a large double-throw triple-pole, three-wire switch and fuse cut-out. The double service is arranged so that if one should fail the other can be thrown into connection with the wiring of the building. A heavy three-wire feeder in iron-armored conduit connects the service to the switchboard, which is located in the rear of the basement hall.

This switchboard is equipped with a main switch and 10 feeder switches, controlling the various feeder circuits ramifying throughout the building. The three-wire system is used throughout for all feeders, main and riser circuits, but all branches from the fuse terminals of the panel board boxes to the outlets and between the outlets are two-wire circuits. The double-throw main switch at the switchboard is arranged to throw the wiring into a two-wire distributing system, if desired. This arrangement is made to provide for the future installation of an isolated generating plant. Two separate sets of bus-bars are provided, one for lighting and the other for power service. A sliding wire gate is placed in front of the switchboard, and the back of the board is very neatly encased by a lighted closet.

The specified drop was from 1 to 1⅓ volt from the service to the cut-out boxes and one volt to the lamp outlets from the boxes. Aside from this the capacity of all circuits far exceeds the maximum load carried by them. All three-wire circuits have a double neutral conductor, equal in cross-section to one of the outer legs. A separate tube is provided for each neutral and one outside leg of the circuit, so that as far as the tube work

goes, the installation is practically two-wire throughout. The ends of the neutral wire are connected together at the switchboard and also at the distributing or cut-out panel boxes. The latter are very excellently designed with white marble panels, have copper contact terminals and are placed in slate-lined panel boxes, in some cases covered by glass doors.

Each of the three main chandeliers is provided with an individual cut-out panel box located directly over the chandeliers in the attic over the main hall, and the two three-wire feeder circuits are run from this box to a large distributing panel on the main floor, from which the chandelier lights can be controlled. Each of these circuits is controlled by a separate knife-switch, and a separate feeder circuit for each chandelier runs to a switch on the switchboard.

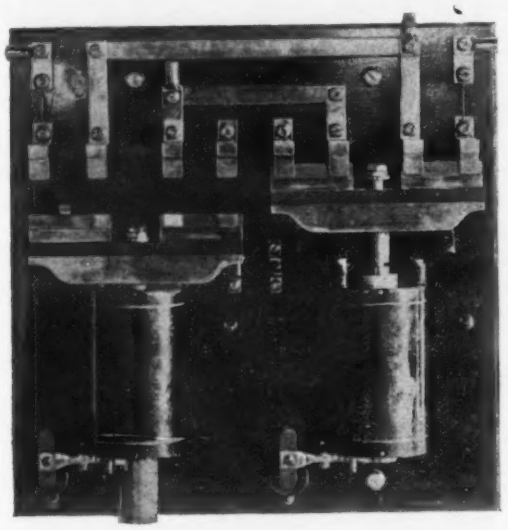


Fig. 2.—Electromagnetic Reversing Switches.

Four three-hp Crocker-Wheeler motors operating reversible ventilating fans are located in the attic over the main hall between the ceiling and the roof. These motors were previously controlled by means of switches and regulators located at the motors, but it was desired in the new installation to use a single supply circuit for all motors and operate them in either direction from the switchboard in the basement. For this purpose a special electromagnetic switch and starting apparatus was devised and furnished by Messrs. Machado & Roller, 203 Broadway, New York City. A No. 0 B. & S. feeder-circuit runs from the switchboard to a distributing cut-out panel box in the attic, and from here four two-wire 110-volt branches are carried to the motors, and electromagnetic switching devices, which are operated by means of separate wires, run in iron-armored conduits to four switches located on the main board, which control the various coils of the electromagnetic switching devices, as shown in the diagram. As this method embodies some new features a description of the same may be of interest.

As will be seen from the diagram and illustrations, the apparatus consists of three distinct parts, namely, the electromagnetic reversing switches, the automatic starting rheostat, and the controlling switch. The fields of the motor are constantly excited from the two-wire 110-volt branch circuit, which is also connected to the reversing switch. The armature terminals are also brought to contacts on this switch, so that by the operation of either of the switch-bars, each of which is controlled by a separate solenoid, the armature connections are suitably changed to effect reversal of the motion of the motor. Each switch contact-bar is attached to an iron core, operated by its respective solenoid coil. One end of the coils from both solenoids is connected to a common wire,

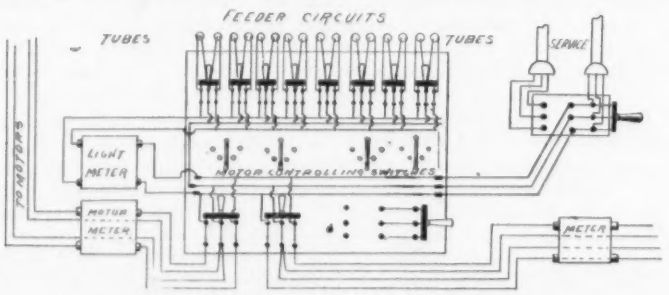


Fig. 3.—Diagram of Connections of Switchboard.

which connects in turn to one side of the main circuit. Each solenoid is wound with two separate coils. The upper coil of each solenoid tends to pull the iron core upward, bringing the switch blades into connection with the terminal clips. This coil in each solenoid is in series with a contact device which is controlled by the other switch bar, so that the circuit in this raising coil of either solenoid is only closed when the other switch bar is down and out of connection. From each of these contact devices the wire is run to terminal contacts on the controlling switch at the switchboard. Either core when raised is held up by a separate latch controlled by a small electromagnet. The windings of these magnets are in series with their respective release coils on the solenoids, and a conductor is run from each release magnet to terminals on the controlling switch. The release coil occupies the lower portion of each solenoid, and when energized tends to bring down the core. The controlling switch at the switchboard governs all the windings of both solenoids. The lever of the switch is connected oppositely to the previously mentioned terminals from all the solenoid coils. If the motors are to be operated in one direction, the switch may for instance be moved to the right into contact with the upper contact terminal which energizes the raising coil of one solenoid, bringing the core upward into connection with the terminal clips from the armature and supply mains. When the core has been sufficiently raised the circuit is broken, as shown, but the core is held by the small magnet-controlled latch previously mentioned. After making contact, the controlling switch-arm need not necessarily remain in connection with the contact terminal; it can be returned to its original position. To release the switch and stop the motor, the contact-lever is brought into connection with the lower left

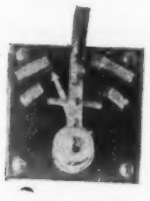


Fig. 4.—Controlling Switch.

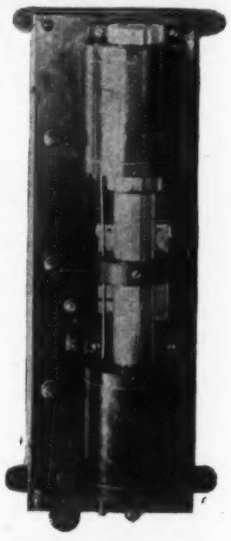


Fig. 5.—Automatic Starting Rheostat.

contact terminal, energizing the small magnet and release coil, which causes the latch to be released and gravity, with the aid of the pull of the release coil acting on the core, tends to open the switch. It will be seen that in moving the arm to either side the release contact of the opposite solenoid is first connected, which ensures the release of the other switch and prevents both switches being in at the same time.

The automatic starting rheostat consists of a solenoid coil connected across the terminals of the motor armature. The core of this coil is provided with a contact bar, and works in a dash-pot at its lower end. The contact bar moves over the resistance contacts and gradually cuts out the resistance in series with the armature when the coil is energized by one of the main reversing switches being thrown in. When the core is all up the circuit of the solenoid coil is broken, but the core is held by a latch, controlled by a small magnet in series with the armature and resistance and arranged to release the core when the circuit is broken.

This apparatus has been improved since the installation at the Stock Exchange. The motor fields are now normally disconnected and controlled by the switch contacts, and three wires instead of four are used to control the switch solenoids as the two release coil terminals are connected together.

Lag and Pipe Wrench.

The Martini patent lag and pipe wrench is a new departure in the line of automatic wrenches and has a number of very desirable features. The movable jaw at the bottom causes the wrench to tighten as the pressure on the handle is increased. The wrench will not slip; takes hold and lets go suddenly, and is always ready. In the operation of this wrench there is no lost motion, and no time consumed in adjusting. The device is made of drop-forged steel. The jaws are made of the best tool steel hardened and tempered, and can be replaced when necessary at very little expense.

Lag and Pipe Wrench.

This specialty has had the approval of practical men familiar with this class of tools, and is already being very extensively used. The Electric Appliance Company, Chicago, Ill., has undertaken to put this wrench on the market, and has the exclusive sale for the same.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, Feb. 10, 1897.

ELECTRICAL STOCKS.—General weakness characterized the electrical stock market during the week just passed, all securities in that list being lower in price at the time of closing our report. Electric Storage Battery was the heaviest loser, the quotations of both common and preferred being over two and three points lower respectively than at the time of our last quotations.

TELEGRAPH AND TELEPHONES.—Bell Telephone shows greater strength, closing at an advance of 1½ points over our last week's quotations. Western Union lost ½ point. The rest of the list was quiet, with practically no change in quotations.

ELECTRIC TRACTIONS.—There seems to be a better tone to the street railway securities market, and holders are asking more for the same. There are, however, no material changes in the bid prices. On Tuesday Brooklyn Rapid Transit stock and bonds were exceptionally strong on buying partly for investment and partly by friends of the management, on the continued increase in earnings shown by the official statements.

THE NATIONAL ELECTRICAL EXPOSITION COMPANY.—On Feb. 4 Mr. George F. Porter, 136 Liberty Street, this city, was appointed by Justice Truax receiver of the National Electrical Exposition Company in a formal proceeding for the voluntary dissolution of that concern. There are no creditors, and the assets, amounting to $20,000, have been distributed as a dividend among the stockholders. This concern is dissolved, having accomplished the object for which it was organized, namely, the holding of the electrical exposition in this city last May.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	110	..
Edison Electric Ill., New York	100	104½	105½
" " " Brooklyn	100	..	97
" " " Boston	100	..	..
" " " Philadelphia	100	..	..
Edison Ore Milling	100	7½	10
Electric Storage Co., Philadelphia	100	27⅝	27¾
Electric Storage, pref	100	28½	29
General Electric	100	35⅛	35¼
General Electric, pref	100	76	78
Westinghouse Consolidated, com.	50	24	25
" " pref	50	50	51

BONDS.

Edison Electric Ill., New York	105	106½	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	95⅛	..

TELEGRAPH AND TELEPHONE.

American Bell Telephone	100	216½	217
American District Telegraph	100	*29	39
American Telegraph & Cable	100	87½	90
Central & South American Telegraph	100	124	127
Commercial Cables	100	156	172
Erie Telephone	100	65⅞	..
New England Telephone	100	102	..
Postal Telegraph-Cable	100	91	94
Western Union Telegraph	100	82½	83

ELECTRIC TRACTION STOCKS.

Baltimore Traction	25	18	18¼
Brooklyn Rapid Transit		20⅞	21
Brooklyn Traction	100	..	14
" pref	100	46	48
Buffalo St. Ry	100	73	75
Cleveland Electric Ry	100	..	..
Columbus St. Ry	100	40	43
Hestonville	100	50½	50¼
" pref		..	62½
New Orleans Traction	100	..	11
" " pref	100	..	45
North Shore Traction	100	22	25
" " pref	100	77	80
Rochester St. Ry	..	18	22
Steinway Ry	..	45	50
Union Railway (Huckleberry)		98	103
Union Traction, rcts $10 pd	..	12¾	13
West End, Boston	100	66½	67
" " pref	100	89½	90½
Worcester Traction	100	20	22
" " pref	100	95	98

BONDS.

Brooklyn Rapid Transit 5s. 1945	100	79	..
Buffalo St. Ry. 1st con. 5s	100	*107	110
Cleveland Elec. Ry. 1st mtge 5s	100	102	104
*Columbus St. Ry. 1st 5s	100	94	96
Rochester St. Ry. 1st 5s	100	..	100
Union Railway (Huckleberry) 1st mtge 5s		*101	104
*Westchester Electric 1st mtge 5s	100	100	103

* With accrued interest.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, Feb. 10, 1897.

STREET RAILWAYS IN MASSACHUSETTS.—We have received a copy of the twenty-eighth annual report of the Massachusetts Board of Railroad Commissioners, relating to street railways in that State. It is for the year 1896, and is very complete in statistical information.

MR. DAVID CHALMERS, 114 Liberty Street, New York representative of the Holtzer-Cabot Electric Company, Boston, is not saying much but is doing plenty of business. Within the past four weeks this veteran has closed contracts for Holtzer-Cabot small dynamos with an aggregate capacity of 60 kilowatts and small motors amounting to 40 horse-power. Mr. Chalmers works quietly but effectively, and his geniality brings him additional business. He is one of the pleasantest gentlemen in the supply trade, and he has been in it long enough to make a reputation that is unassailable. All his friends—and many there are—wish him well.

STEVENS INSTITUTE TWENTY-FIFTH ANNIVERSARY.—Active preparations are being made for the twenty-fifth anniversary of the founding of the Stevens Institute of Technology, Hoboken, N. J., which will beheld Feb. 18 and 19. The banquet will be held at the Hotel Waldorf, New York City, and will be largely attended by graduates and undergraduates, as well as by many representative men in the engineering and mechanical arts, who have been invited to be present. The exhibition of the work of the institute's graduates will be one of the most prominent features of the occasion, and many of the exhibits will be shown in actual operation. An electric light plant operated by a gas engine will represent one of the later developments in this particular field. The exhibition of photographs and working drawings of apparatus designed and work carried out by graduates will form a conspicuous feature of the exhibition and will be opened to the public at the institute on Feb. 18.

SUBSTITUTING STREET SERVICE FOR ITS ISOLATED PLANT.—Mr. Arthur Williams, chief inspector of the Edison Electric Illuminating Company of New York, reports that the above company has recently added to its list of customers the Havemeyer Building, located at Prince Street and Broadway, New York City. This plant is one of the largest in this city, including some 8000 incandescent lights and a number of motors which were originally intended to be operated by means of an isolated plant in the building. It appears, however, that for some reason the owners of the building have decided to discard the isolated plant for continuous use, retaining it only for relay service, and take current from the Edison street mains. Five thousand incandescent lamps have already been turned over to the street service, and it is stated that the remainder are to be turned over as soon as possible. This fact is particularly notable in view of the present controversy regarding the relative merits of isolated plants and central station service.

ELECTRIC SURFACE LINES IN THE CITY.—President H. H. Vreeland of the Metropolitan Street Railway Company, stated on Monday last that the contract had been let for the engines and electrical machinery necessary to equip the Sixth, Eighth and Amsterdam Avenue lines on the west side of the city, and the Fourth and Madison Avenue lines on the east side, also the Fifty ninth Street crosstown line. The same system will be introduced on these lines that is now operating on the Lenox Avenue line. Work will be commenced as soon as the weather becomes sufficiently settled to make it practicable, and Mr. Vreeland states that unless some unforeseen hindrance intervenes, he expects to see the lines in operation next Fall. He states that property holders along the line have been free in giving their consents to the change. The Lenox Avenue underground conduit, Mr. Vreeland states, is giving satisfaction to the residents along the road, and this fact has had a great influence with the residents along the routes of the proposed new lines in giving their consents.

MEETING OF THE MAGNETIC CLUB.—The Winter meeting of the Magnetic Club was held at the Hotel Manhattan, corner Forty-second Street and Madison Avenue, New York, on the night of Feb. 4, and was probably the most enjoyable the club ever had. There was a large attendance present and members and guests to the number of about 150 sat down to a fine dinner at 7 o'clock. The dinner was held in the magnificent dining-room of the Transportation Club, on the twelfth floor of the hotel. At its conclusion the new president, Mr. Edward H. Johnson, was introduced and made a few appropriate remarks, thanking the members for the honor conferred upon him and promising to give his lively aid in advancing the interests of the club. Mr. J. R. Van Wormer, of the Lincoln National Bank, New York, next spoke on the subject of the bill passed by Congress and signed by the President on Jan. 26 last, providing for the granting of certificates of services rendered the United States Government by the Military Telegraph Corps during the Civil War. He referred to the faithful devotion of these telegraphers to their duty and offered resolutions—which were unanimously adopted—extending to the Military Telegraph Corps the club's most cordial congratulations, and expressing its profound satisfaction that Congress had at last given recognition to the patriotic devotion of this faithful arm of the military service.

Col. A. B. Chandler, president of the Postal Telegraph Cable Company, also made a few remarks on the same subject and congratulated the war operators on their success in obtaining recognition by the Government. Mr. W. J. Dealy read letters of regret at their inability to be present at the meeting from Gen. T. T. Eckert, Major McKelvey and Col. C A. Tinker. Each of these gentlemen spoke in praise of the services of the military corps during the war, and congratulated the members of that body on their final success in obtaining official recognition. Remarks were made by other gentlemen, after which the musical part of the entertainment was carried out. This consisted of some excellent vocal and instrumental music, and as a finale the company joined hands and sang "Auld Lang Syne," which terminated what was generally acknowledged to have been the most enthusiastic and enjoyable meeting ever held by the the club during its existence of nine years. Among those present were many persons of prominence in almost every branch of electrical industry. President Johnson received a large number of applications for membership, and under his guidance there is every indication that the Magnetic Club will thrive as it never has before, although it has always been a prosperous institution and very popular among the electrical fraternity in New York City.

Western Notes.

Branch Office of The Electrical World,
936 Monadnock Building,
Chicago, Ill., Feb. 8, 1897.

MR. J. E. WAY, New York manager for the R. Thomas & Sons' Company, East Liverpool, O., manufacturer of porcelain electrical specialties favored the Chicago office of The Electrical World with a call a few days ago.

MR. C. M. TURNQUIST, 216 South Clark Street, Chicago, is doing a very satisfactory trade in his line of electrical supplies, and manages to always keep busy. His electric bell outfit is meeting with popular favor, and his continuous ringing electric alarm clock does its work effectively. Mr. Turnquist's illustrated catalogue is different from ordinary trade lists, and presents his wares in an attractive manner.

THE DEARBORN ELECTRIC COMPANY, 19 Quincy Street, Chicago, is doing an active business in the electrical supply line, and is perceptibly forging to the front. The company has sold quite a number of its Dearborn long distance telephones, in one case three sales being made to one customer inside of 30 days. This latter fact speaks well for these telephones, and although the concern is a new comer in the field, it is working hard from merit a good share of the business.

English Notes.

(From Our Own Correspondent.)

London, Jan. 27, 1897.

OBITUARY.—The death is announced of Mr. John Aylmer, until recently honorary local secretary and treasurer in France to the Institution of Electrical Engineers. At the last annual general meeting of the Institution, just before Christmas, generous testimony was paid to Mr. Aylmer's services in this capacity by the secretary and others. Mr. Aylmer took a prominent part in connection with the electrical and other exhibitions which have been held in Paris during the last 20 years.

PROF. SILVANUS THOMPSON'S PACIFIC CABLE.—Prof. Silvanus Thompson has recently been unbosoming himself to a reporter of an evening newspaper with regard to his scheme for rendering the Pacific cable possible. Prof. Thompson's idea is to use a metallic circuit cable and to introduce at certain intervals high resistance inductive leaks between wire to wire. Of course in the *Pall Mall Gazette*, Prof. Thompson is reported in such a way that the ordinary reader would imagine that he took credit for the discovery of leaks in submarine cables. Of course Prof. Thompson only claims credit for proposing one of a number of different suggested methods of using these, and in a recent issue of *The Electrician*, Mr. F. Alex. Taylor, of the Eastern Telegraph Company states that the effect of leaks was known to Varley. Mr. Oliver Heaviside, as I have no doubt your readers are aware, has developed the whole theory of leaks, how they increase the clearness and decrease the intensity of signals, etc., etc. Mr. Taylor informs the readers of *The Electrician* that having made experiments on artificial cables, he did not find the results particularly satisfactory, for reasons which can easily be assigned by Mr. Oliver Heaviside. Prof. Thompson does not seem to have developed either the theory or practice of the matter and claims credit merely for one of a number of suggestions as to how to make a cable judiciously leaky. The *Pall Mall Gazette*, however, does not seem to be able to distinguish between a discoverer and a suggester.

THE FIRE INSURANCE OF ELECTRIC LIGHTING STATIONS.—As I have had occasion once or twice recently to state, the decision of the fire insurance companies in this country to raise the tariff on electric lighting central stations from 5s to 10s 6d per centum, has given rise to considerable heart-burning, especially among the municipalities, and the air is blue with schemes for circumventing the exactions of the tariff offices. The Brighton Corporation recently effected their entire municipal assurance through a non-tariff office known as the Fine Arts and General. The Bristol Corporation apparently also contemplates some such step, and the chairman of the Electric Lighting Committee of that town, Mr. Alderman Pearson, will read a paper to-morrow before a special meeting of the Municipal Association dealing with the general question of municipal insurance, in regard to which his ideas, so far as municipal electrical undertakings are concerned, is that electric lighting committees should induce their Town Councils to allocate a lump sum out of the first annual profits to an insurance fund, and gradually decrease the amount insured in the tariff offices as the municipal insurance fund is built up. Mr. Alderman Pearson says he was at one time sanguine that the municipalities might take part in a mutual insurance scheme, but on further consideration he thought that the conditions were so different in different towns that no common premium could be arrived at, and that there would be endless quarrels between municipalities as to the rate which should be applied to each. An interesting discussion will, it is expected, take place on the reading of this paper.

ENGLISH ELECTRIC LIGHTING RETURNS.—The electric lighting returns called for by the Board of Trade for the financial year 1895-96 are now complete. From these it would appear that the capital expenditure upon electric lighting undertakings in London by 11 companies and three vestries amounts to a total of 4½ millions sterling. A very good criterion of the dividend-paying capacities of a concern is the capital expenditure of any concern per kilowatt-hour sold by it. Taking the six dividend-paying companies in London which have sent in full returns, one finds that the average capital expenditure of these six companies amounts to 4s. 6d. per Board-of-Trade unit sold, the maximum figure being 9s. and the minimum figure 2s. 6d. It is also seen from the returns of the six dividend-paying concerns that the ratio of expenditure to receipts is about 60 per cent., and the average cost of coal per unit sold is ¾d., the poorest showing being ⅞d., and the best about ½d. Of the 18 provincial concerns which have been in operation for a year, have an output of at least 60,000 units and have sent in full returns, the largest by far is the now defunct Liverpool Electric Supply Company which had a capital expenditure of £264,000. This concern has, since these returns were sent in, suffered a painless euthanasia, that is to say, it has been absorbed by voluntary arrangement by the Liverpool Town Council. The next biggest provincial concern is the Birmingham Electric Supply Company which has a capital expenditure of £136,000. Omitting these two abnormal undertakings, the average capital expenditure of the 16 remaining companies dealt with in these returns amounts to £52,000, so that it will be seen they are, for the most part, of comparatively modest dimensions. The coal bill of these provincial concerns averages a little more than 1d., that is to say, 30 per cent. more than the average for the best six London companies The capital expenditure per Board of Trade unit amounts to more than 5s. 6d., that is to say, to more than 25 per cent. above the average for the six best London companies. Turning to municipal enterprise in the provinces it is seen that they are somewhat larger than the joint stock undertakings. The average capital expenditure of the 30 concerns dealt with in the returns amounts to nearly £59,000. Municipal enterprises have apparently more judiciously applied their capital than the joint stock undertakings, since the average capital expenditure per Board of Trade unit sold amounts to less than 4s. 6d. The municipal concerns seem also able to turn out their units for a lower expenditure of coal, their average coal bill per unit amounting to a little more than ¾d., the three lowest towns being Burnley, with a coal bill of .29d.; Aberdeen, with a coal bill of .33d., and Edinburgh, with a coal bill of .38d. per unit. While on the subject of electric lighting undertakings in the United Kingdom, I may mention the fact that the directors of the St. James & Pall Mall Electric Lighting Company have just announced a 10½ per cent. dividend for the year 1896. Since it commenced operations eight years ago, this company has paid dividends ranging from 4½ to 8¾ per cent. Probably this is more satisfactory from the fact that so far as one can see from the very full returns of the company, this big dividend has been honestly earned. The £5 shares of this company now stand at 130 per cent. premium.

General News.

New Incorporations.

THE EAST WINDSOR ELECTRIC RAILWAY COMPANY, Windsor, Conn., has been incorporated by J. H. Simonds, C. G. Harrison and S. D. Rockwell.

THE ELECTRIC PARK CHUTE COMPANY has been formed in St. Louis, Mo., with a capital stock of $75,000. Those interested are George Grisler, John H. Fuller, August Westing and others.

THE MUTUAL TELEPHONE COMPANY, Erie, Pa., has been formed with a capital stock of $25,000. The incorporators are F. F. Adams, William Hardwick, William B. Trask, J. F. Downing and J. P. Metcalf.

THE BAY SHORE ELECTRIC COMPANY, Bay Shore, L. I., has been incorporated by Freeman F. Maise, Josiah Robbins, John R. Howell and Edward B. Mowbray. The capital stock of the new company is $10,000.

THE NEW CASTLE, NEWPORT AND WILMINGTON ELECTRIC RAILWAY COMPANY, Dover, Del., has been organized with a capital stock of $100,000. The company was once chartered, but failed to build and the charter lapsed.

THE MIDLAND ELECTRIC LIGHT COMPANY OF RICHMOND COUNTY, has been incorporated at Port Richmond, S. I. The capital stock of the company is $100,000 and the directors are William E. Rockwell, Ernest G. Wightman and Merle J. Wightman.

THE SEWICKLEY VALLEY ELECTRIC PASSENGER RAILROAD COMPANY, Sewickley, Pa., has been incorporated with a capital stock of $15,000 to build a line about two miles long through Sewickley. The incorporators are James D. Callery, Pittsburg; W. I. Keech, J. C. Reilly, George C. Wilson, and J. M. Tate, Jr.

THE NORTH JERSEY TRACTION COMPANY has been incorporated at Camden, N J., for the purpose of operating and maintaining a trolley road in the counties of Union, Middlesex and the town of Perth Amboy. The capital stock is $100,000, and the incorporators are Theodore T. Hansen, George D. Armstrong and Richard H. Turner.

Telegraph and Telephone.

FREMONT, O.—There is every indication that the telephone line between this city and Gibsonburg will be built.

GRANTSBURG, WIS.—A telephone line will probably be built in the Spring between here and Trade Lake.

INDIANAPOLIS, IND.—The Council proposes to build a police station and put in a complete police patrol telephone system.

ROCK ISLAND, ILL.—It is stated that the Central Union Telephone Company will introduce on its lines the selective signal system to take the place of the present party line system.

WALWORTH, N. Y.—Work on the telephone line from this place to Walworth Station has been suspended probably until Spring on accoun of the weather. It is now probable that the line will then be extended to many other neighboring towns as a company has been formed with Mr. A. Yeomans, of Walworth, as president.

CLYDE, N. Y.—The Wayne Telephone & Telegraph Company, at its annual meeting, elected officers as follows: President, A. B. Bishop, of Clyde; vice-president and secretary, Earnest W. Brown, of Palmyra, N. Y.; manager, S. E. Bishop, of Clyde; treasurer, George Brisben, of Clyde. The company in the Spring will extend its lines and install exchanges in Lyons, Newark and Palmyra.

MACOMB, ILL.—It is reported that another telephone exchange will be established in this place. Hon. Tom A. Marshall, of Keithsburg, is interested in the project, which forms part of the Marshall-Toble system of telephone lines. This company's lines now run from Macomb to Bushnell, thence to Abingdon. The new extension will open up the territory along the Quincy branch and will include several points.

MEMPHIS, TENN.—The Cumberland Telephone Company has practically completed arrangements for the extension of the long distance telephone system from Memphis to Helena, Pine Bluff, Little Rock and points in Arkansas and Texas. Work on the construction of the necessary lines to complete the system will be commenced at once, and it is stated that by May 1 next Memphis will be in telephonic communication with the above-named points. Mr. Charles J. Glidden, of Lowell, Mass., vice-president of the Southwestern Telegraph & Telephone Company, and Mr. P. G. Reynolds, general superintendent of construction, are in the city completing arrangements, in conjunction with the local officials, for these extensions.

SPRINGFIELD, ILL.—A bill has been introduced in the House by Representative Barnes to regulate telephone charges and provide for a closer supervision of the telephone companies' affairs by public officials. The bill also proposes to increase the taxes paid by these corporations. The measure declares all telephones, whether leased, owned or operated by individuals, copartnerships or corporations, to be common carriers. Every telephone company shall permit any other person or corporation operating a telephone line to connect its wires by any device or system commonly used for long distance telephones and shall receive and transmit all messages that may be offered by the connecting company. The charge for a five minutes' conversation shall not exceed 25 cents within a radius of 50 miles from the place where the message originates, and ½ cent per mile for the distance in excess of 50 miles. The actual telephone rental is fixed at $5 per month.

ELECTRIC LIGHT AND POWER.

ELKHORN, WIS.—A movement is on foot to establish an electric lighting plant.

FAIRPORT, N. Y.—It is understood that this village is soon to have an electric light plant.

WOLFEBOROUGH, N. H.—The question of street lighting by electricity is being considered.

GREENFIELD, MO.—J. C. Longfield is seeking a franchise to put in an electric light plant.

RACINE, WIS.—The Belle City Electric Light Company has passed into the hands of a receiver.

LIMA, O.—The Council is considering the feasibility of establishing a municipal lighting plant.

WESTERVILLE, O.—The citizens will vote on the proposition to put in a light and water plant.

CHARDON, O.—The Council has under consideration the establishment of an electric light plant.

GEORGETOWN, CONN.—The question of an electric light plant at this place is being agitated.

FORT SMITH, ARK.—A new power house will be built by the electric light company in the Spring.

LEBANON, O.—Mayor Gustin is investigating the cost of putting in an electric lighting plant by the city.

BROOKINGS, S. D.—An election will be held to vote on issue of bonds for the establishment of a lighting plant.

REDWOOD FALLS, MINN.—The question of introducing electric lights into this place has been again revived.

COLUMBIA, TENN.—Mr. E. E. Erwin is interested in a project to establish an electric light plant in this place.

GRENADA, MISS.—The citizens have voted to issue $43,500 worth of bonds to establish a system of lights, water and sewers.

FLEMINGSBURG, KY.—The Council is discussing the advisability of issuing $5000 in bonds for the erection of an electric light plant.

DEMOPOLIS, ALA.—The Demopolis Electric Light & Power Company has purchased a site on which it will erect an electric light plant.

MT. PLEASANT, O.—Mt. Pleasant is considering the question of lighting the town by electricity from the plant of the Long Run mines.

MT. STERLING, O.—The village has voted to issue $3000 in bonds to pay existing debt and extend the water mains and electric light lines.

HAGERSTOWN, MD.—The Hagerstown Electric Company has purchased ground and will construct a new 800-hp electric plant, 80 x 130 feet.

LANCASTER, KY.—A franchise for the establishment of an electric light plant at this place has been granted to C. H. Patterson & Co., who will build at once.

NEWARK, O.—The Citizens' Electric Light & Power Company, of which W. C. Taafel is manager, will put in a duplicate set of machinery to run 600,000 more lights.

CORTLAND, N. Y.—Mr. John C. Hamlin has been endeavoring to interest local capital to organize a stock company to operate another electric light plant in Cortland.

HIGHTSTOWN, N. J.—Contractor William Morgan has purchased a plot of ground on the lake at Hightstown, near the new bridge, for the erection of an electric light plant.

BEAVER, PA.—The Town Council has appointed a committee to ascertain the probable cost of erecting an electric light plant in connection with the borough water works.

PAULDING, O.—The Village Council of Paulding, having passed an ordinance to light the town with electricity, is now preparing plans preparatory to advertising for bids.

MAQUOKETA, IA.—F. H. Maskery is engineering a big electric light and power enterprise for the benefit of Maquoketa. His plan is to utilize the water-power at Canton.

OWATONNA, MINN.—At the meeting of the Council, Jan. 19, the City Attorney was instructed to prepare an ordinance to submit the question of bonding the city to establish a municipal lighting plant.

JEANNETTE, PA.—The Gill Glass Company, Philadelphia, will erect a large gas plant on the line of the Pittsburg, Jeannette & Greensburg Electric road. The company will manufacture incandescent lamp bulbs.

XENIA, O.—A tract of land has been secured by the Martin Supply Company and work will be commenced as soon as the weather permits erecting an electric light and gas plant and cold storage works. The firm will also manufacture ice.

BRAZIL, IND.—Messrs. Decker & Son, of this place, contemplate the installation in their establishment of a gasolene engine and dynamo for the purpose of lighting their stores. They want 50 lights of 32 candle-power each and invite estimates on such a plant.

PALMYRA, N. Y.—The Palmyra Electric Light & Power Company has recently placed in its plant a C & C generator for furnishing power for the J. M. Jones printing press works at this place. It will also furnish power for several printing establishments and for other commercial purposes.

DALLAS, TEX.—The city will receive plans and specifications and proposals for building an electric light plant for the public lighting of the city. The approximate wants of the city will be as follows: Four hundred arc lights (double), 2000 candle-power; 1000 incandescent lights, 30 candle-power; 30 miles of wire in four circuits; necessary boiler power, engine power, poles, etc. building to be furnished by the city. All plans and proposals to be received by March 1. For further particulars address T. L. Lawhon, city secretary, Dallas.

THE ELECTRIC RAILWAY.

WAUKEGAN, ILL.—The Bluff City Electric Railway Company, it is reported, will build a line from Waukegan to Cranston, Ill.

BALTIMORE, MD.—The Falls Road Electric Street Railway Company was granted permission to extend its tracks on Lafayette Avenue from Maryland Avenue to Charles Street and also to extend its proposed line in the Annex between Woodbery and Mt. Washington.

WEST NEWTON, PA.—The West Newton Northern Street Railway Company connecting West Newton and Herminie, was recently granted a charter at Harrisburg. The directors are James E. Bell, West Newton; T. F. Vankirk and P. M. Null. The line will connect with Greensburg *via* the Hempfield branch of the Pennsylvania Railroad. It will be in operation by Fall and eventually be completed to Greensburg.

JERSEY CITY, N. J.—The announcement comes from Washington that arrangements have been completed between the Post Office authorities and the Consolidated Traction Company for carrying the mails by the latter concern from the main post office in the cities through which its lines run to the branch offices and also between the cities and towns. It is expected that the mail service will be commenced about Feb. 15.

ATLANTA, GA.—It is practically settled that the Chattahoochie River electric line will be extended to Marietta before the end of the coming Summer. This movement to connect the cities of Marietta and Atlanta with a rapid transit electric railway system has been under consideration for some time and is now about matured. The originator of this project is C. J. Simmons, president of the Chattahoochie River Street Railway Company.

CHICAGO, ILL.—A dispatch from Chicago on Feb. 3 stated that a report was in circulation there to the effect that Mr. Charles T. Yerkes and Mr. J. Pierpont Morgan were engaged in a project to consolidate and control the traction lines in Chicago. According to the report the plans contemplated securing a controlling interest in the Chicago City Railway Company for the purpose of bringing that property into the large consolidated traction company covering all three divisions of the City of Chicago. The scheme also includes the absorption of the City Railway Company and its consolidation with the General Electric Railway Company, which has just obtained a valuable franchise from the City of Chicago. It was also announced that Mr. Yerkes had succeeded in placing a $10,000,000 consolidated bond issue on the property of the West Chicago Street Railway Company through the assistance of Mr. J. P. Morgan.

SOMERVILLE, N. J.—The Somerset County Board of Chosen Freeholders, on Feb. 4 approved the plans and granted concessions which permit the New York & Philadelphia Traction Company to enter this town over the county bridge crossing Peters Brook. This is said to be the first link in the chain of trolley lines which constitute the New York & Philadelphia Traction road. The Traction Company was restrained two years ago from continuing the construction of its line by the Central Railroad of New Jersey. A satisfactory agreement has since been made between the opposing interests by which the Traction Company will cross the Jersey Central's tracks between this place and Raritan under grade. Assurances were given, it is stated, by the Trac-

tion Company officials that the line between Somerville and Bound Brook will be in operation about May 1 next, after which it will be extended to New Brunswick, Plainfield and other towns.

OBITUARY NOTE.

MR. M. B. LEONARD, an electrical engineer of some note, and telegraph superintendent for the Chesapeake & Ohio Railway Company, died at Richmond, Va., the place of his residence, on Feb. 6. Mr. Leonard was affected with a cancer of the throat, and was being placed upon General Manager Stephens' private car to be brought to New York for treatment, when he was found to be dying. The deceased was widely known among the railway telegraph fraternity, and was the inventor of several railway signal appliances. He was one of the most active members of the Railway Telegraph Superintendents' Association, and was its president during the last year. Mr. Leonard was born in Philadelphia on June 14, 1856. He was a member of the American Institute of Electrical Engineers.

PERSONAL NOTES.

MR. W. M. SHEEHAN, electrical engineer and contractor, Newburg, N. Y., has recently returned from South America by way of England, whither he went on a pleasure trip.

MR. S. Z. de FERRANTI and Mr. J. B. Atherton, of the British Insulated Wire Company, London, will arrive in this country the latter part of March to visit the various electrical industries in the United States.

Mr. L. B. STILLWELL.—It is reported that Mr. L. B. Stillwell has resigned hisposition with the Westinghouse Company to accept one as electrical director of the Niagara Power Company and the Cataract Construction Company.

Trade and Industrial Notes.

THE BALL & WOOD COMPANY, 120 Liberty Street, New York, which received the order to install its engines in the Edison Electric Illuminating Company's plant, Paterson, N. J., has just shipped one 750 horse-power engine which completes the order given for ten.

SALE OF THE McEWEN ENGINE WORKS.—The assignees and receivers of the J. H. McEwen Manufacturing Company, Ridgway, Pa., will offer for public sale all the property, rights and franchises of that company, on Feb. 22. The sale will be conducted at the Court House in Ridgway.

THE WABASH RAILROAD COMPANY has placed on its day train, leaving Chicago at 8.55 a. m. and arriving at Detroit at 5.40 p. m., new buffet parlor cars. The old 20 minutes for dinner is a thing of the past and no longer threatens the digestion of passengers on the Wabash short line to Detroit. Meals are now served *a-la-carte* in the new buffet parlor cars.

MR. JOHN T. McROY, Chicago, has secured another extensive contract for his terra cotta conduit. He has arranged to supply the Metropolitan Street Railway Company, New York City, with 40 miles of it, aggregating 700,000 feet of six chambers. It is reported that the McRoy conduit is giving excellent satisfaction in Brooklyn and wherever else it has been laid. All who know Mr. McRoy will be pleased to learn of his deserved success.

THE CENTRAL ELECTRIC COMPANY, Chicago, has taken the agency for the new Benjamin waterproof socket. This socket, designed by a man of many years' experience in construction work and particularly work pertaining to street railway operation, is all that its name implies; it is so constructed as to be attached directly to a $\frac{7}{16}$ or $\frac{9}{16}$ iron armored conduit; has sufficient metal in its shell to stand a great amount of very hard usage, and wherever used has easily proven its superiority.

FINE PANEL BOARDS.—A number of very highly finished panel boards have just been completed by J. Jones & Son, 67 Cortlandt Street, New York City, for F. S. Kinney's new Newport residence. These boards are of white Italian marble placed in marble-lined boxes with bronze frame, glass doors, and all copper parts, screws, bolts, etc., are finished in bronze. These very artistic panel boards have attracted much attention. Messrs. Jones & Son intend to make a specialty of this class of work.

THE PURITAN ELECTRIC COMPANY, 150 Nassau Street, New York, reports that its Boston office is doing a very flourishing business. Mr. S. W. Wise, general manager of the company, has just returned from an Eastern trip. He states that the company will be represented in New England by Messrs. J. B. Chamberlin and Malcolm H. Baker, with headquarters at the Boston office. These two gentlemen are preparing to do some active work in New England, and sound the praises of the Puritan arc lamp.

HIGH-TENSION INSULATORS.—Mr. Fred M. Locke, Victor, N. Y., advises us of the receipt of information from California to the effect that the power-transmission line between Sacramento and New Castle, Cal., carrying 1000 horse-power, 30 miles, at 15,000 volts, on which are used Mr. Locke's patent triple-petticoat china insulators with steel pins, has been in operation for two months through some very stormy weather and is giving excellent satisfaction. There is no leakage whatever on the line, Mr. Locke states, and he is naturally very much pleased with the receipt of this information. Over 20 lines of this character are now using Mr. Locke's insulators and pins.

MR. H J. GORKE, well known in the electrical trade as general manager of the Electric Engineering & Supply Company, Syracuse, N. Y., has resigned his position and started a business of his own. He will act as manufacturers' agent and handle general electrical supplies, including machinery for electric lighting and power. Among the concerns Mr. Gorke will represent in Syracuse may be mentioned the Perkins Electric Switch Manufacturing Company, Hartford, Conn., the Eddy Electric Manufacturing Company, Windsor, Conn., and many other prominent manufacturing concerns. Mr. Gorke's new headquarters are at 120 The Bastable, Syracuse, N. Y., and with his large experience he will certainly do well.

THE BERLIN, CONN., POWER PLANT—The contract for the new power station to be erected for the New York, New Haven & Hartford Railroad Company, at Berlin, Conn., has been let to the Berlin Iron Bridge Company, East Berlin, Conn. This building will be 110 feet in width and nearly 200 feet in length, divided into two equal portions, one side to be used for a boiler room and the other for an engine and dynamo room. The engine and dynamo room will be provided with a runway and 35-ton traveling crane. The whole framework is to be of steel, the side columns being enclosed by brick walls, and when finished will be one of the most complete, expensive and best power stations in the world, as no pains or expense have been spared to make it a model.

THE CHAPIN-DOUGLAS ELECTRIC COMPANY, 136 Liberty Street, New York City, has been appointed New York agent for the Stromberg-Carlson telephones, made by the Stromberg-Carlson Telephone Manufacturing Company, 70 to 82 Jackson Street, Chicago, Ill. This company manufactures telephone appliances of all kinds for long distance and general work, including a non-infringing metallic circuit switchboard of new finish and a desk-set instrument which can hardly be surpassed in artistic design. The Chapin-Douglas Company is now representing a very large number of electrical manufacturers for this district. It reports a recent single order for 8000 pounds of weather-proof line wire. Business seems to be flourishing with it.

NEW SAND BOX.—The Metropolitan Electric Company, Chicago, has secured the Western agency for the Ham sand box. This is a new device for distributing sand and gravel on the rails, while the cars are in motion, and is used on railroad trains as well as street cars. The great trouble with the sand boxes now on the market is that they operate with a valve, and this valve gets clogged up with the sand and gravel passing through it. The Ham sand box, however, avoids this difficulty entirely, by omitting the valve, and substituting a simple device for equally distributing the material to be used on the tracks, whether it be sand, gravel or salt. The best evidence that the box is a good one is that the company is putting them out on trial, not to be paid for unless satisfactory, and in addition to this it is making a very low price on this sandbox.

MR. HENRY R. WORTHINGTON has just been awarded a contract by the City of Chicago, covering six vertical triple-expansion direct-acting high-duty pumping engines, each of 20,000,000 gallons daily capacity. This contract amounts to $437,600, and is the largest contract for water works pumping machinery ever placed in this country. The above six engines each have a daily pumping capacity of 20,000,000 gallons against a head of 150 feet, and will be supplied with steam at a pressure of 140 pounds to the square inch. The engines will each be of 530 horse-power. This company is also building three vertical triple-expansion direct-acting high-duty pumping engines for the City of Brooklyn, N. Y., under a contract amounting to $385,000. These engines each have a daily capacity of 20,000,000 gallons to be delivered against a head of 168 feet, and the steam will be supplied at a pressure of 135 pounds to the square inch, each engine being of 600 horse-power.

ELECTRIC HEATING APPARATUS.—The almost universal use of electric lights in hotels and apartment houses interferes seriously with the use of many household conveniences, and being alive to the needs of the times the American Electric Heating Corporation, Boston, Mass., in addition to providing small portable stoves, chafing dishes and curling iron heaters (which may be attached to lamp sockets), offers to the trade a small laundry iron of very convenient form and handsome finish. It is especially designed for the household sewing room and for ironing laces, handkerchiefs and other light work. The current required is two amperes on 110-volt circuits and the iron is made for direct or alternating current, and for all the usual voltages as, in fact, are all of the company's appliances. A feature of all of the new electric heating appliances is that they reach the desired temperature in from two to three minutes, and because of their perfect cleanliness and other conspicuous advantages over the older methods seem to be ideal.

THE PECKHAM MOTOR TRUCK & WHEEL COMPANY, 26 Cortlandt Street, New York, has just issued an 84-page handsomely illustrated catalogue describing the various trucks and truck appliances which it manufactures for electric, cable and steam railway service. The publication is very comprehensive; the detail parts of the apparatus are carefully shown and excellent half-tone cuts are given of each style of truck. The points of advantage of each type are clearly and concisely set forth and the principal dimensions are given. Numerous full-page illustrations of cars mounted upon Peckham trucks are also shown. Strong testimonials from prominent railway officials throughout the country attest the excellent reputation attained by the Peckham appliances and a two-page list is given of the companies who are using Peckham apparatus. The usual energetic, thorough and systematic methods of the Peckham Company have been followed in the publication of this catalogue, which will form a valuable addition to the literature on street railway apparatus.

THE MURRAY IRON WORKS.—This concern, whose establishment is located at Burlington, Ia., has recently equipped its works with many modern labor-saving machines and appliances. The plant was established in 1870 and has grown in size year by year. It consists of a foundry, machine shop and boiler works, very conveniently situated upon the line of the Chicago, Burlington & Quincy Railway. Hitherto the output has been throttling stationary engines, mining engines, ice and refrigerating machines, boilers, heaters, etc. In order to be in line with the tendency of the times the company decided to build Corliss engines, and with this end in view, purchased the plant of a concern in Sioux City, which built what is known as the Sioux City Corliss engine. A new shop was built at Burlington adjoining the old ones and Corliss engines —both single and compound—have been turned out from there for the past six months. The Murray Iron Works Company's plant possesses first-class facilities for building boilers and engines, and is now in position to supply complete power plants. From the number of inquiries received the company confidently looks forward to a large trade with the opening of Spring.

LONG-BURNING ARC LAMP.—The new La Roche long burning enclosed alternating-current arc lamp manufactured by the Ideal Electric Corporation, Thirteenth and Hudson Streets, New York City, is meeting with more than ordinary success, which is apparently due to the elimination of all objectionable features which have been considered as inherent defects in this type of

lamp. This new lamp is of the chain feed focusing type and is fitted with an inner arc enclosing globe. Exceedingly simple mechanism and positive and noiseless operation are among its principal features of merit. With 10-inch carbons the lamp burns 100 hours, and is connected independently without resistance or economy coil on either 52 or 104-volt circuits. These excellent features seem to be generally appreciated as the company's shops are taxed to fill orders. Blades, switches, panel and switchboards are also extensively manufactured by this concern. All switch contacts and conducting parts are made of 98 per cent. pure copper. Special attention is given to theatre switchboards. Among the recent switchboards built are those for the Star Theatre Murray Hill Theatre and Lyceum Theatre, and the Bowling Green office building, New York City. Mr. La Roche is the president and general manager of the company.

THE WILSON-BATES ELECTRIC COMPANY, 126 Liberty Street, New York City, who is the metropolitan agent for Ericsson telephone appliances, is installing a number of extensive interior telephone systems. The Ericsson coal-grain transmitter and Ericsson receiver, described in a previous issue, are used in these plants, but the arrangement of the various devices forming each station is somewhat changed, in order to conform to American ideas. Among these new installations are the following New York City buildings: St. Paul Building, Ann Street and Broadway, 360 single stations (one for each office), each separately connected to a central switchboard on the main floor; Bowling Green Building, 5 to 11 Broadway, 300 separate stations connected to a central switchboard; Ninth Regiment Armory, Fourteenth Street, 22 intercommunicating stations; Bloomingdale Asylum, 15 stations, with central switchboard, and Roosevelt Hospital, 12 stations operated from three central switchboards. Nearly all of the above buildings are equipped with wall-set instruments. It is to be noted that the St. Paul and Bowling Green buildings are among the first office buildings to be equipped with a complete private telephone system connecting each office with a central station. The entire product for this country, of L. M. Ericsson & Co., Stockholm, Sweden, who manufacture these instruments, is controlled by Smith & Patterson, 256 Broadway, New York City.

Business Notices.

THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 67–71 Park Place, New York City.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED FEB. 2, 1897.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

11,588. ELECTRIC METER; J. Harris, Lynn, Mass. App. for re-issue filed Oct 18, 1895. The combination with a pressure coil and a motor, of a torsion-spring connected to said coil and to said motor, whereby the torsion of the spring automatically balances the torque of the coil. (Re-issue.)

576,082. AUTOMATIC SWITCH; J. P. Alexander, Jackson, Tenn. App. filed May 29, 1896. A switch for electric circuits comprising a dividend and balanced circuit, switching devices connected in a bridge across said balanced circuit, mechanical means for disturbing the balance of the balanced circuit, and connections controlled by the switching devices for closing a supply-circuit whenever the balance of the balanced circuit is disturbed.

576,095. BATTERY; W. S. Doe, Brooklyn, N. Y. App. filed Feb. 29, 1896. A battery comprising a carbon cylinder adapted to receive an exciting fluid, a perforated non-conducting tube suspended in said cylinder, a cartridge in said tube comprising a cylindrical anode having an outwardly opening and a depolarizer in the anode and a contact with which the anode engages.

576,103. ELECTRIC ARC LAMP; P. H. Fielding, New York, N. Y. App. filed April 23, 1896. In an arc lamp, an opaque case made of heat resisting material having a reflector formed on its inner surface and provided with a transparent window, openings in the case to admit the carbons, said openings being substantially air tight and the case being hermetically sealed at all other points, whereby the life of the carbon is prolonged and the heat of the arc does not tend to injure the case.

576,129. ELECTRICAL ADVERTISING DEVICE; L. Julig, San Francisco, Cal. App. filed Dec. 26, 1895. The combination with a stationary base and a table rotatable thereon; of a revoluble globe on an upright spindle which is also a conductor, stationary magnets, a vibrating armature lever carried on one end, an armature arranged to move across the field of said magnets, the rotatable shaft, one end of which is geared to the globe-spindle and the opposite end connected to the armature-lever by a crank and pitman, a commutator on the said shaft, a stationary arm and commutator-brushes secured thereto, one brush arranged in working relation with the cut-away portion of the commutator and the other brush set to make continual contact with the cylindrical portion of the shaft next the commutator, a conducting ring with which the lower end of the globe-spindle is in electric contact, the contact-spring connecting the commutator-brushes with such ring, and a contact-spring completing the connection electrically between the said brushes and the central post of the structure, and the springs and connections completing the circuit through the said parts between the wires from the two poles of an electric battery.

576,145. METHOD OF AND APPARATUS FOR ELECTRIC PROPULSION; L. H. Nash, South Norfolk, Conn. App. filed Nov. 16, 1895. The combination with an electric generator run at a substantially constant speed, of a translating device constructed and arranged to translate into work a constant energy in watts at varying potential and current, said generator having on its field magnets shunt and series coils wound in opposite directions whereby constant watts at varying potential and current are supplied to the work circuit as the resistance of that circuit varies.

576,163. PASTE CARRYING MACHINE FOR ELECTRIC ACCUMULATORS; F. W. Schneider, Triberg, Germany. App. filed Jan. 13, 1896. A paste carrying plate for electric accumulators consisting of a frame and parallel bars therein, having lateral projections and being connected each to the next by bridges in form of undulating or zigzag bands, said bridges having respectively on their front and rear sides lateral openings and central projections perpendicular to the faces of the plate.

576,164. CONSTRUCTION OF CELLS FOR ELECTRIC ACCUMULATORS; F. W. Schneider, Triberg, Germany. App. filed May 2, 1896. The combination with an exterior vessel, of a resilient insulating plate in the base thereof, angular bars on said plate, negative electrodes having noses and positive electrodes having noses, perforating insulated plates between said perforated plates and electrodes resting on the bars, and rods covered with elastic insulating material between said noses and the side of the vessel.

576,166. AUTOMATIC BLOCK SYSTEM; J. Shoecraft, Harveyville, Kan. App. filed May 7, 1896. An automatic block signal system comprising a signal at each end of a block section, a closed electric circuit comprising a ground-wire containing a battery and the signal magnets, a second wire connected at each signal system with the ground wire and a relay in each of said wires of which the armature forms part of the other wire.

576,177. ELECTRODE FOR STORAGE OR OTHER BATTERIES; T. A Willard, Norwalk, O. App. filed Nov. 7, 1895. An electrode having a series of shaved leaves of uniform thickness from edge to base and formed in undulating lines the full depth of the leaf whereby the active material is confined.

576,178. BATTERY PLATE; T. A. Willard, Cleveland, O. App. filed May 4 1896. A battery plate having its sides provided with extremely thin parallel shaved leaves of equal thickness from the extreme edge to the base thereof and with a uniform space between the said leaves from their extreme edge to their base in which the material is enabled to form and expand.

576,201. AUTOMATIC STREET OR STATION INDICATOR AND ADVERTISING MEDIUM; M. B. Leece and A. R. Bullock, Cleveland, O. App. filed June 2, 1896. The combination in a street or station indicator of six or more longitudinal rollers carrying a film or ribbon of celluloid or other flexible material, together with sprocket wheels and ratchet wheels together with their pawls, and two electrical solenoids in combination with an electric switch.

576,202. RHEOSTAT; H. W. Leonard, East Orange, N. J. App. filed July 30, 1895. The method of making apparatus in which an electrical conductor is applied to a metal surface which consists in coating the metal surface with a layer of infusible insulating material applied as a powder and made by heat into a coherent layer adhesive to the metal support, and placing the conductor upon said layer.

576,240. ELECTRIC METER; J. R. Tucker and C. C. Hincklet, Aurora, Ill. App. filed Jan. 25, 1896. An electric meter comprising a movable contact-surface, a motor for operating the same, a planimeter-wheel adapted to engage said contact surface, said planimeter wheel connected with a movable frame adapted to be moved about an axis, a pinion connected with said planimeter wheel so as to be operated thereby, a registering mechanism provided with a second pinion adapted to engage said first mentioned pinion at a point substantially at the axis of rotation of said movable frame, and a connecting device between said movable frame and a device responsive to the current to be measured, said connecting device so constructed that the position of the frame is varied by the variation of the current.

576,243. CONTACT APPARATUS FOR TELEGRAPHING; C. Vreede, Rotterdam, Netherlands. App. filed Jan. 6, 1896. In a contact apparatus for night signaling and telegraphing, the combination with an electric circuit normally interrupted, a source of electrical supply, a support, a ring rotatably mounted on said support, segmental strips of non-conducting material removably secured to the ring, conducting strips carried by the segmental strips, said conducting strips being of varying widths, and being separated electrically from each other, and electrical contacts adapted to come in contact with the different conducting strips when the ring is rotated and close the electric circuit.

576,266. ADVERTISING DEVICE; H. Green, Hartford, Conn. App. filed Feb. 8, 1896. In an incandescent light globe having a capped or coated surface and provided with a letter or character on one or more of its sides and also on its end, whereby parts of said globe are rendered opaque by such surface.

576,267. ADVERTISING DEVICE; H. Green, Hartford, Conn. App. filed May 2, 1896. An incandescent electric light globe in combination with a freely-removable device having one or more letters or characters thereon and provided with means for directly engaging the bulb of said globe.

576,268. CONTACT BOX FOR DEPRESSIBLE CONDUCTOR RAILS; W. Grunow, Jr., Bridgeport, Conn. App. filed May 8, 1896. A contact box which is adapted for use in connection with electrical railways, provided with a depressible contact rail, said box or casing being provided with a suitable cap or cover, and near the bottom thereof with a transverse non-conducting partition plate or bar, provided with perforations and on which is mounted a conducting bar with one end of which a cable or conductor is connected, said box being also provided with a vertically-movable insu

lated shaft which is adapted to make contact with the opposite end of said bar, and which is adapted to be depressed by the depressible rail.

576,332. LOCKING DEVICE FOR ELECTRIC CONTROLLERS; G. Valley. Johnstown, Pa. App. filed Nov. 10, 1896. In an electric controller, a locking device comprising two contiguous rotatable discs, one of said discs having a plurality of lunes about its periphery, the other of said discs having a plurality of suitably connected concentric arcs composing its periphery.

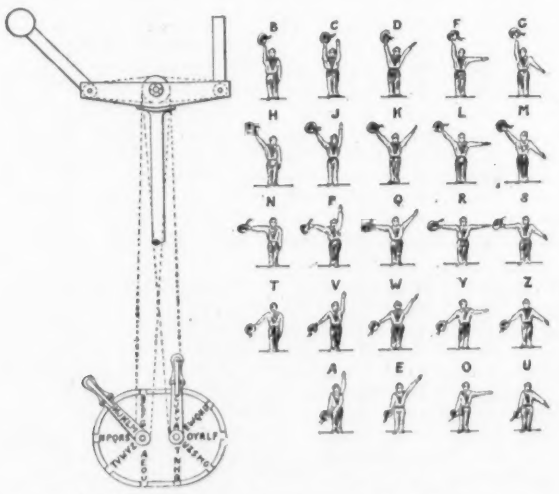
576,333. ELECTRIC CONTROLLER; G. Valley, Johnstown, Pa. App. filed Nov. 10, 1896. In an electric controller in combination, two movable groups of contacts adapted to regulate the course of the current by engagement with fixed contacts and an electric switch which affords means by which either group alone or both of said groups may be used to supply current.

576,342. ELECTRICALLY OPERATED MUSICAL INSTRUMENT; G. H. Davis, New York, N. Y. App. filed March 25, 1896. In an electrically operated musical instrument, the combination with a key, of an armature connected to said key, an electromagnet for actuating said armature, a source of electrical energy for energizing said magnet, a resistance and means operated by the armature when the latter is attracted by its magnet for cutting the resistance into the circuit to reduce the current passing through the magnet.

576,347. ELECTRIC HEATER; F. A. Johnson, Binghamton, N. Y. App. filed Feb. 24, 1896. A magnetic induction heater, comprising a case having an opening to receive the article to be heated, a coil surrounding the opening, a laminated magnetic shell surrounding the coil and a connector whereby the heater may be connected to an ordinary alternating-current circuit and the article to be heated applied in the opening and heated.

576,369. AUTOMATIC ELECTRIC CUT-OUT; C. C. Kritzer, Newaygo, Mich. App. filed Nov. 13, 1895. In an automatic cut-out consisting of an electromagnet, an armature corresponding to the action of an abnormal current, main contact plates, a stationary high resistance supplemental-contact plate and a roller of like material as the stationary supplemental contact-plate resting, when in normal position, upon the stationary supplemental contact-plate and adapted to roll along the side supplemental plate, thereby increasing the resistance gradually until the latter is separated from the supplemental plate, which is after the separation of the main contact plates.

576,372. AUTOMATIC CUT-OUT FOR MAGNETO BELLS; J. Z. Miller, Baltimore, Md. App. filed Sept. 23, 1896. In electric cut-outs, the combination of a main line parted; each of the parted ends provided with a spring contact-point; a mechanical shunt-piece normally in contact with the said spring-points; a third spring located opposite to one of the said two springs and electrically connected with one terminal of a magneto generator, a level electrically connected with the other terminal of the said generator and provided with a contact point located opposite to the other of the said two springs, and further provided with an insulated shield opposite to the third spring; a magneto generator drive-wheel and a crank therefor having a shaft loosely connected therewith; a cam-wheel mounted upon the crank-shaft to be rotated therewith but with free longitudinal movement thereon, the adjacent faces of the cam and drive-wheel being cam-shaped; a spring freely connecting the said wheels, and an arm of the aforesaid lever bearing against the end of the cam-wheel.

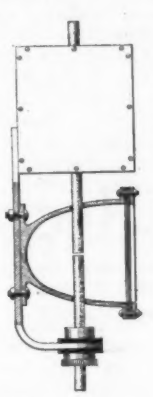


No. 576,243.—Contact Apparatus for Telegraphing.

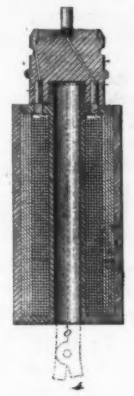
576,375. SPRING JACK; W. S. Paca, Baltimore, Md. App. filed Sept. 23, 1896. The combination in spring jacks of a switch-plug having one or more laterally projecting lugs connected with line wires, a switchboard provided with a socket to receive the said plug freely, the said socket having longitudinal slots with side-wise recesses to receive the said lugs, a longitudinally acting spring within the socket and electrical connections for the socket and spring.

576,383. ALARM FOR ELECTRIC CIRCUITS; C. B. Sterling, New York, N. Y. App. filed June 24, 1895. In an electric distributing system, the combination of a conductor from a generator to a distant point, a circuit maker and breaker for said line, a shunt around the said circuit maker and breaker, an electromagnet, controlling an indicator in said shunt, a branch circuit including the circuit maker and breaker and a return conductor to the generator, an electromagnet in said branch, a circuit-closer operated by the last named magnet, and means in the circuit closed by said circuit-closer for sounding an alarm when the circuit of the branch is broken through the circuit maker and breaker of the main line.

576,384. BRAKE MECHANISM AND CONTROLLER FOR ELECTRIC CARS; W. D. Thomas and L. R. Gignilliat, Savannah, Ga. App. filed June 2, 1896. In a controlling device for electric cars, the combination with the regulator or controller, and brake operating devices, of an actuating shaft rotatably mounted in suitable bearings and held against longitudinal movement therein, and clutch mechanism located between said actuating shaft and brake operating devices with means for automatically causing the clutch mechanism to connect and release the actuating shaft and brake operating devices at predetermined points in the rotation of the shaft, the said means being operated solely through the rotation of the actuating shaft.



No. 576,103.
Electric Arc Lamp.



No. 575,347.
Electric Heater.

576,392. INSULATOR; H. E. Billings, Hartford, Conn. App. filed Nov. 21 1894. An insulator comprising a body portion having a tapered, transverse opening extending therethrough; a cap for closing the large end of said opening, a deflector carried by the body portion of the insulator; and a unitary line-wire-supporting insulator-stud having a screw-threaded end, a head tapered toward its shank to correspond with the taper of the opening in the body, a polygonal head between said screw-threaded end and the tapered head and adapted to be engaged by a wrench or similar tool and an insulating medium of high resistance surrounding said tapered head and similarly tapered and adapted to fill the space between such head and the walls of the tapered opening.

576,394. TROLLEY FOR ELECTRIC CARS; G. L. Campbell, Shunk, Pa App. filed March 18, 1896. The combination of a post, a trolley pole pivotally mounted thereon, a trolley wheel carried by the pole, an arm pivotally mounted on the pole, a spring in connection with the arm and pole, a flexible connection actuating said arm, the connection being attached to the pole, and an idler pulley carried by the post and over which the connection passes.

576,405. SPIRAL TROLLEY WHEEL; C. A. Langford, St. Louis, Mo. App. filed May 25, 1896. A trolley wheel comprising a wheel having an annular groove in its periphery, a stationary shaft supporting said wheel, a yoke supporting the ends of said shaft, wheels having spiral grooves mounted upon said shaft, one upon each end of said first-mentioned grooved wheel, said spiral groove being designed to throw the trolley wire toward said first-mentioned grooved wheel by the friction contact of said trolley wire with said grooves, said spirally grooved wheels being over-balanced, so that the inner ends of their spirals will normally be at the top of said wheels.

576,469. SWITCH PLUG; W. S. Paca, Baltimore, Md. App. filed Sept. 23, 1896. A switch plug comprising alternate sections of metal and insulating material provided with screw and socket joints and abutting shoulders and a switch-cord comprising one or more conducting-wires and insulating material passing within the body of the plug, and the ends of the wires being secured between the said abutting shoulders in electrical contact with the metallic sections.

576,472. TELEPHONE SIGNAL TRANSMITTER; E. C. Robes, Medford, Mass. App. filed July 25, 1896. A signal transmitter for a telephone substation circuit adapted to automatically send multiple independent arbitrary, consisting of a motor mechanism, a signal sending mechanism, a telephone hook switch controlling the detents of both and means for simultaneously setting the required signals and winding the actuating power of said motor and signal-sending mechanisms, whereby when the signal-sending device is set the motor is wound up; when the telephone is removed from the hook switch the signal is sent to line and the circuit closed, and when the telephone is returned to the hook-switch, the apparatus is restored to its normal condition.

576,475. ELECTRIC ARC LAMP; D. A. Shesler, Toledo, O. App. filed Feb 13, 1896. In an electric arc light, the combination with the upper carbon of a lower carbon, an insulated support therefor, a conductor adjacent to the insulator, and a solenoid interposed in the circuit adjacent to the carbon and to the conductor adjacent to the insulated support therefor.

576,514. APPARATUS FOR STOPPING ENGINES; G. W. Brown, West Newbury, Mass. App. filed Oct. 4, 1895. The combination with a vent-controlling valve, of an actuator moved by the power of the engine and a coupling device or clutch member actuated by the power of the engine to connect the actuator with the valve.